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THE CHINESE, AND RECENT INDUSTRIAL PROGRESS IN CHINA.

By J. S. Fearon and E. P. Allen.

IMAGINE an empire greater in area than the United States or Canada, occupied by a population of 500,000,000,—a population possessing a highly-developed civilization, industrious and peace-loving, whose appreciation of the importance of trade is not second to that of the great commercial nations of the west,—and you may have some conception of the magnitude of the new field for engineering enterprise which is now being opened to the world. China is not a new country; it requires no pioneer. No railroad constructed through its territory will have to import its patrons; no mine opened in its hills and valleys will have to send its product to far markets. The producer and the consumer are alike on the ground. The opportunities are ready made; all that is wanted is the application of western science to the means of production and transportation in order to make of China a country of the greatest developed wealth.

It is strange that, with so long a peaceful occupation of their land, with natural resources so rich and varied staring them in the eyes, and withal themselves gifted with a high degree of intelligence and a never-ending activity of mind and hand, the Chinese, left to themselves, have yet been able to progress only so far and no farther; but there seems to be a possible explanation. Dr. W. A. P. Martin, an American, who has lived some forty years in Peking, for twenty years has been the president of the Imperial Tungwan College, and has lately been called to the presidency of the new Imperial University established in that city, and who has therefore had ample opportunity to observe the mental characteristics of the Chinese, remarks that

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they seem to lack the ability to apply abstract principles to practica affairs. In other words, the Chinese lack the synthetic faculty, and have but vague and impractical ideas of natural law. The inventions attributed to the Chinese are of the obvious sort, literally "invented" or "come upon." Having observed the polarization of a needle, accidentally placed in favorable conditions for that phenomenon, the application to use in the mariner's compass is obvious, and the Chinese had the mariner's compass in very early days; but they did not induce the laws of magnetism from the small beginning of the polarized needle, as we have done, and have in consequence stopped short with the obvious compass, while we have, from the laws once ascertained, not invented, but deduced and contrived, a multitude of the most wonderful appliances which now form a matter-of-course part of our daily life.

Yet this does not mean that the Chinese are incapable of progress; for, however much they may be lacking in the synthetic faculty, they are well-endowed with the analytic; they are capable, in a word, of understanding anything that is capable of demonstration, and, having once seen and studied, they are able to imitate to the smallest particular. It follows, therefore, that, in order to bring China forward to a prominent position in the industrial and commercial world, it is necessary only for the west to show the way.

China's conservatism is a by-word among the nations, but it is not a quality to be despised; for it has been the quality that has held together the vast empire for these thousands of years. Without it we should now have, not one people to deal with, but a score or more. The semi-autonomy of the provincial governments is bad enough as it is; but how much worse it would be if even the shadow of imperial authority no longer covered the whole land! It is to the interest of western nations that the central authority in China shall be upheld, and particularly is this to the interest of the United States. The destruction of the central government at Peking would mean a breaking up of the empire along the lines of provincial cleavage, and that would entail a serious retardation of all progressive measures of imperial dimensions now projected. Fancy the difficulty of constructing, and the greater difficulty of operating, a railway from Peking to Canton, across half-a-dozen frontiers, with innumerable taxes to pay and endless official interference to oppose! Such a condition would not be permitted to remain, and the destruction of the Peking government would therefore be the signal for a final and irrevocable partition of China, in which the United States would scarcely have a part. If China is divided, England would come into her share without aid from the United States, and there would be no share for

Americans to appropriate. It will be too late for the United States to seek a benefit by arraying themselves on the side of England when her operations and influence are confined to the valley of the Yang-tze. Russia, Germany, and France seem already to have acquiesced in England's supremacy in central China, and, if England must give up the fight for the open door throughout the empire, she can have the Yang-tze valley as a *quid pro quo*, and will not need any assistance, moral or other, from America. But England is far from showing any disposition to confine herself to the Yang-tze valley. In the southwest the boundaries of the important Chinese province of Yünnan are coterminous with those of England's possessions in Burmah, and England purposes to extend her influence northward from Burma *pari passu* with the extension of French influence northward from Tong King. In the province of Shansi at the north an Anglo-Italian syndicate, known as the Peking syndicate, has acquired concessions for exploitation covering an area larger than that of Great Britain. The great rivalry is therefore not appeased; the question of the open door is not settled, and the opportunity is not yet gone from the United States.

They have certain treaty rights in China. If they do not extend these rights, they should, at least, maintain them. It is their right to trade on the same terms as other treaty nations at every open port. But their treaty rights with China do not extend to any territory the sovereignty over which China has ceded to another power. When therefore the United States stand idly by, and merely watch the slow encroachment of Russia, Germany, and France upon the sovereign rights of China, they are permitting themselves to be robbed without protest. The controversy over Newchwang is a case in point. The Chinese government had arranged to borrow from the Hongkong and Shanghai Bank, a British institution, the money needed to complete the Imperial railway from Peking to Newchwang, in Manchuria, and to mortgage the Newchwang extension to the bank as security. Contracts to this end were duly signed. Russia, fearing the possible ultimate British control of the railroad in what it claims as its own peculiar "sphere of influence," which would result from a default in payment of principal or interest of the loan, brought to bear so strenuous pressure that the government was induced to break its contract. Russia, however, had no interest in the completion of the Newchwang road, even under other control; she had the further object in interfering with the loan in question, that her plan is to make her Manchurian coast connection, not with Newchwang, which is an open treaty-port, but, disregarding that point altogether, to pass it fifteen miles to the eastward, and make an outlet at Talienwan, which

she holds by lease from the Chinese government, and which it will be her purpose to build up to the detriment of Newchwang. It was only after diplomatic interference of the British government that the rights of the Hongkong and Shanghai bank received recognition. Americans are as much interested in this controversy as the English, if not more so, because a very large part of the foreign trade in Manchuria is American.

Heretofore American merchants abroad have been very much left to shift for themselves, and not infrequently they have found it difficult to obtain from Washington the influence and backing necessary to maintain their rights. If the American nation desires now to inaugurate a policy of imperialism really effective and beneficial, it cannot do better than eliminate, as far as possible, all territorial bounds, and bring its government to guarantee to every citizen, wherever he may be, its full protection against wrong and its full power to enforce right. The government need not take the initiative, if the citizen is sure that its influence will follow him wherever he may go. And the influence of the government must follow the American into China, if American enterprise in that country is to be encouraged, for the conditions are such that governmental pressure may frequently be necessary to compel the Chinese—and particularly the Chinese official—to live up to his contract. The Newchwang railway loan may again be referred to as a case in point. There is therefore the strongest possible reason for the Anglo-Saxon nations to co-operate in policy as to the future of China.

The Chinese have an elaborate system of jurisprudence; their abstract conceptions of right and wrong are seldom at fault, even when viewed from our standpoint; but their practical morality and their administration of law fall far short of the condition which would promote easy and safe commercial intercourse. In strict accordance with the utilitarian principles governing the evolution of morals, the Chinese merchant has achieved integrity simply because he has learned that honesty is the best policy, and that without honesty in himself he cannot expect honesty in his fellow; but the average official knows no policy except that of lining his pockets while he has the opportunity. Happily, there are notable exceptions; but the honest statesman in China is seriously, and sometimes overwhelmingly, handicapped by the numerical preponderance of the class of self-interest. The verbal agreement of the Chinese official is generally worth nothing; his written contract is of scarcely more value, unless obligation is allied with self-interest. Americans now contemplating engineering enterprise in China should arm themselves, in every possible way, against breach of contract, and there is perhaps no means to this end

so efficient as the enlistment of Chinese co-operation, and financial co-responsibility.

These observations, of course, do not apply to enterprises within the limits of the extra-territorial jurisdiction of treaty ports. At these ports, and notably at Shanghai, the great commercial center of the east, there are opportunities to operate under peculiarly-favorable auspices, and with the minimum of interference by Chinese official-dom.

It is to the credit of the Chinese that, even when they recognize the benefits to be derived from the introduction of the material improvements of the west, they are still unwilling to throw open their country indiscriminately to the foreigner, but prefer themselves to take as large a part as possible in the new development.

The Chinaman has some force of character, and resents most strongly the encroachment of the "barbarian," as he terms all outlanders,—resents it not merely as the savage African does, but with patriotic feeling and a natural desire to owe his progress to no one but himself. Years ago China was warned by a far-seeing and sympathetic missionary, Dr. Allen, of Shanghai, in his book, "China and Her Neighbors," that, if she did not develop her own resources, the foreigner would do it for her, and bring her to the condition of another India or Egypt. Some of her statesmen have heeded the warning, but they have found it difficult to move the great inert mass of the people. Comparison is frequently made between Japanese advance and Chinese stand-still; but, without regard to stability of character, it is easier to move forty millions than five hundred millions. Yet the leaven has been working strongly of late, and results are showing. Despite palace revolutions, there can be no withdrawal now from the march of progress. The whole civilized world is behind China to push forward the unwieldy mass which her own nerves are inadequate to direct. Nothing has proved a stronger lever to uplift the Chinaman from his medieval drift than the hurt to his pride which has come from the contempt and distrust of his institutions expressed in the extra-territorial provisions of the treaties with western nations; a recent demand of Japan to be placed in the same category with western nations in the matter of extra-territorial jurisdiction has been the unkindest cut of all. It has taken a long time to convince even the few among the people that this distrust at least was justified; but now a Chinaman is to be found who says, with Confucius: "The first thing for a man to learn is his faults; then the good he learns in the morning he can make his own and practice in the evening." In other words, recognition of defect must precede the search for, and application of, the remedy. China has become convinced that there is a

world, and a great one, beyond her borders—that the "outer nations are no longer insignificant," and that it is worth while for her to prepare herself to take her place in the greater family of nations, assuming no superiority, but grateful for recognition as an equal. The leaders of thought and action among her people are, therefore, anxious to promote progress in every direction; but, unfortunately, they do not realize that the chief claim to national equality is not in equal material advance, but in equal moral advance. It is proposed to revise the body of Chinese law; that work is even now quietly on the way, and the establishment of laws less alien to western ideas will do much to break down existing barriers; but, until the practical morality of the people has advanced beyond the possibility of tolerating the corrupt administration of law and government that now obtains, no change in the letter will accomplish any real progress.

So much for the social conditions which will confront the foreigner in China. But, when the difficulties presented by these conditions are successfully evaded or guarded against, the field of enterprise that opens before the engineer is unparalleled in its richness and variety.

The coalfields of Shansi alone, according to von Richthofen, will suffice, at the present rate of consumption, to supply the world for a thousand years. The province of Kansu is not far behind; no department of this province appears to be without considerable deposits, and, in some departments, the supply is enormous. "The coal formation extends, with few interruptions, from eastern Shansi to Ili, through 30 degrees of longitude, and it is also found near Ili and Yarkand." Much of the coal is anthracite, and the bituminous variety is of high grade. Von Richthofen says the province of Shansi will take the palm from Pennsylvania in its coal area, and by a relatively greater proportion. Says Mr. Colquhoun, in his "China in Transformation:" "Nor is its extent the only advantage possessed by the Chinese coal-field, the ease and cheapness with which coal can be extracted being a remarkable feature. This region, however, labors under the disadvantage of being situated at a distance from the coast and from navigable rivers; and the coal formation lies a few thousand feet above the adjoining plain, a difficulty which will be overcome by the railroads required for the exploitation of the mineral wealth of Shansi."

"The district of Luiyang, from which the famous coal of this name comes, forms the most important mining center of a region which is broadly estimated as extending over 20,000 square miles. It is from this source that the future coal-supply of central China must chiefly be drawn, but it is the extent of this vast field, in addition to

the commercial capacities of so populous a region, which renders the opening of Hunan to foreign enterprise a matter of such importance. The coal has long been worked in many localities, under the primitive methods of Chinese surface-mining, for purposes of local supply, and a varying quantity (probably some 200,000 tons a year) is sent to Hankow, four hundred and thirty miles distant. The Luiyang and Yungling mines are capable of producing an unlimited supply, the cost of which would be nominal with good communications and scientific methods of production.

"In Hunan the fields bordering on the line of the proposed Luhan railway—*i. e.*, the Peking-Hankow line—produce an excellent quality of bituminous coal, sold at about 3s. at the mines, and iron ore occurs profusely throughout the coal-bearing strata of this district, while in north Hunan there is also an anthracite belt. Coal from these mines finds its way to the Yellow river and the Wei, about thirty miles distant, where it commands a price five times that paid at the pit-mouth.

"In Shansi, still bordering on the Luhan railway line, lies the great coal and iron region of Tszchow Fu, favorably situated at a distributing center. In northern Shensi, also rich in coal, the difficulties of transportation place it entirely beyond the reach of any but the adjacent places. The coal formation in the bottom of the ravines is so similar to that of Shansi as, in Richthofen's opinion, to make it probable that the table-lands of coal extend over the greater portion of northern Shensi."

The coal deposits of the upper Yang-tze valley are described by an engineer in the *Imperial and Asiatic Quarterly Review* for July, 1898, as follows:

"Ten miles below the city of Suchau, (situated at the confluence of the Min Kiang and the Yang-tze, 1,750 statute miles from Wusung) we arrived at the great coal-mines of Pa-Ko-Shau; and on examination it was proved that this coal was superior to that found in any other part of the river we had yet explored, and, under the action of heat, it was far more combustible. Extensive mining was being carried on by horizontal galleries. Iron is also found in this neighborhood. After ascending 25 miles above Su-chau, we came to the great Coal-Gorge (so named by us). This is 14 miles long, the cliffs on either side being from 500 to 600 feet in height. The coal-seams crop out from these precipices, and at every turn the galleries were being worked by the natives, some of these galleries being 400 feet above the level of the river. The coal is sent down in baskets, on two permanent taut ropes, to the junks below, the empties being carried up by the weight of the descending load. At some places the

height at which the coal is worked is so great that two or more of these contrivances are necessary, one bringing down the coal to a half-way landing, and the other thence to the river. A vast number of junks transport the coal to Su-chau, thence ascending the river Min to Ching-tu, the capital of Sze-chuan."

Coal of excellent quality is also found in Yünnan, which is south of Sze-chuan.

The only coal mines in China that are now being worked to any considerable extent and with foreign machinery are the Kaiping mines in northern Chihli. These mines have a yearly increasing output, and are a decided success. The present output is 1,500 tons per day, and a new shaft is now being sunk which will double that amount. Their product is taken partly for the imperial navy, but is chiefly consumed by Shanghai, where exists a demand largely exceeding the supply. The mining company owns and operates four large steam colliers in its Shanghai trade.

Salt is found in great quantities, notably in the extreme west, and the salt gabel is a very important part of China's internal revenue, amounting to some 13,952,000 taels (ounces of silver) per annum. Iron, copper, gold, silver, lead, tin, and zinc are found in many parts of China and in great abundance. The mineral wealth of the southwest provinces, Yünnan and Kweichow, however, is especially remarkable. There sulphur, mineral oil, and mercury are also found. The chief obstacle to mining in that section is the periodical flooding, which native appliances are insufficient to prevent or remedy.

Copper and lead are produced chiefly in Hupeh and Hunan, and in the southwest provinces before mentioned. Copper is also believed to exist in Shantung, the present German "*hinterland.*" Despite the large deposits of copper ore which have been noted in China, a great deal of copper has been, and still is, imported from Japan. It is largely used in the common coin of the realm, popularly known as cash. Chinese copper cash may be said to be on a bullion basis, and, with the decline of silver, they have risen in value from 1,100 to the silver dollar to 800 to the silver dollar; notwithstanding their value as currency, the scarcity of copper for use in the arts is such that, of late years, cash have been melted down in appreciable quantity.

Gold is found in many provinces of China proper and in Manchuria. Silver is also found in various parts of the empire, and has long been mined, but in a measure that has not prevented China from being a principal consumer of the American product. The exploitation of placer gold deposits in the valley of the Moho, near the Amur river, was projected and commenced in 1888. Li Hung-Chang advanced 100,000 taels, and the military governor of Hei

Lung Chang 40,000 taels, toward the preliminary expense. The scheme was first to repay the loans and then to divide net profits in the proportion of 30 per cent. to the support of the army, 20 per cent. as a bonus to the men employed, and 50 per cent. to the shareholders. Gold was then being mined under American engineering superintendence near Pingtu in Shantung. Near Jeho, also in Shangtung, two mines of argentiferous lead ore were being worked with foreign machinery as early as 1888. At each mine a shaft 300 feet deep was opened to water-level. The natives had mined in that locality for forty years, and had taken out all the ore down to the water-level, but their appliances were unequal to the task of going further. It remained for the American miner to import pumping and hoisting machinery from San Francisco, and take up the work where the native had left off. The funds for the machinery, some 30,000 taels, were furnished by the viceroy of the province. He was especially interested in the lead product of the mines, because no lead mines, as such, had theretofore been worked in China, and that metal was largely used for military purposes.

The telegraph is the only institution of modern science which has obtained any considerable foothold in China. Peking is connected by wires with Tientsin and with Manchurian points up to the Russian frontier, whence connection is continued by Russian Siberian lines to Europe. The capital is also connected with all the treaty ports and principal cities in China proper, and these again with each other. Canton has connection also through Yünnan with Burma. China learned the value of the telegraph in the war with France, and it has long since been admitted to have "become indispensable." The telegraph, however, is under imperial control, and there is probably little opportunity for its extension as a private enterprise.

Chinese writing being not alphabetic but syllabic, and there being as many characters as there are words in use, the telegraphic messages are sent in a number cypher. For transcribing messages received a double-ended type is used; on one end is the character, and on the other the corresponding number. When a message is received, it is set up by the numbers, and then printed from the reverse, or character, end.

Government arsenals and shipyards have not been established in China to any considerable extent, but the arsenal on the Woosung river, near Shanghai, is worthy of more than passing notice. It has been in operation under British superintendence for some thirty years, and at the present time is doing much and very creditable work, turning out, for instance, guns, from small arms to 12-inch cannon. The plant includes two Siemens-Martin steel furnaces and

a 2,000-ton forging press. All the steel for guns up to 6″ calibre is made from native pig, and cast and forged at the works. More than two thousand men, all Chinese, are employed, and under their British superintendents they have developed a very satisfactory skill.

A staple agriculture product of central China is cotton, and it is in Shanghai that the industry of cotton manufacturing has established itself and is fast reaching most considerable proportions. There are now, at Shanghai, nine cotton mills with a total of 375,000 spindles. The product is almost wholly yarns, which are woven by the peasantry on hand-looms in their otherwise-idle winter months.

The cotton of China is of exceedingly short staple, and the improved saw gin of American short-staple practice has been found unsuitable. The less-satisfactory roller gin is now employed in Shanghai; the question of an improved gin, adapted to Chinese cotton, presents an excellent opportunity for American invention.

The subject of railroad development in China, in which the engineering world is now taking a very active interest, will be treated in the next number of THE ENGINEERING MAGAZINE.

THE STEEL FOUNDATION OF THE SHIP-BUILDING INDUSTRY.

By James Riley.

THE latter half of the century now nearing its close has witnessed the commencement and rapid development of the manufacture and use of steel, and therefore deserves to be called, as it is, the age of steel. In this development there has naturally, and indeed inevitably, been large opportunity for the exhibition of the interplay between improved material and increased application. New uses have imposed steadily-increasing requirements; the satisfactory fulfillment of these requirements has resulted in increased utilisation and enlarged production, which has again enabled higher economy in manufacture and stimulated still fuller employment. This is especially observable in the applications of steel to structural work, and preëminently in the vastness—the completeness—of its adoption in naval construction and marine engineering.

At the end of the "fifties" Bessemer was deeply and anxiously engaged in perfecting his magnificent invention, the "pneumatic" or "bessemer" process for the manufacture of steel "without the use of fuel."

The end of the "sixties" saw Siemens similarly engaged with his beautiful "open-hearth" process, which, by reason of the readiness and comparative ease with which the products could be controlled, was to win eventually preëminence over its great rival in the matter of regularity and uniformity of product.

By his singularly opportune production of "the triple compound" of carbon, manganese, and iron—"spiegeleisen"—Mushet had saved both the great processes, if not from absolute failure, at least from extremely serious difficulties, and had rendered possible the production of metal capable of innumerable applications.

The utility of spiegeleisen depended on its carbon and manganese, and their relative proportions. The carbon was a fairly constant quantity, about 5 per cent.,—and the manganese ran about 10 per cent., rarely exceeding 12. In using this tolerably definite compound it is evident that, in adding to the refined pig iron in the "convertor," or furnace, a sufficient quantity to furnish the resulting steel with the desired and necessary percentage of manganese, there was also added a more or less definite quantity of carbon. The charac-

teristics of steel in the matter of strength, ductility, etc., are largely dependent on the carbon it contains, but the quantity of carbon which could be added from the spiegeleisen was controlled by the proportion of manganese the latter contained and the quantity which it was permissible or desirable to add to the steel. The other possible method of varying the content of carbon in the steel was to leave more or less carbon in the bessemer "blow" or the Siemens "charge;" this residuum added to the carbon furnished by the spiegeleisen would give the desired percentage in the steel. It is evident, however, that, even if the "blow" for "charge" were thoroughly decarburized, it was not possible to reduce the carbon in the steel below a certain minimum dependent on the composition of the spiegeleisen.

Hence, there was a definite restriction on the steel product in the direction of "softness," "mildness," ductility, etc., qualities which were so much desired for many purposes.

Extended range of variation in this direction could not be accomplished until the "triple compound" could be made with larger proportionate contents of manganese, and this did not appear possible while its production was confined to the ores then in use.

In 1872, however, there was a "spiegeleisen famine," due to the Franco-German war; the writer of this article was urged by his employers to try to give them relief, and as there were no ores of the usual character available, determined to try the manganiferous ores of the south of Spain.

In the end perfect success was attained, a new source of supply was made available, and—what was also important—it was found possible to nearly double the manganese. Thus the utility of the "triple compound" was largely increased, and the steel-maker enjoyed a larger range in the variation of his product.

Important though these new processes and products were, however, still more important operations were in the meantime being conducted elsewhere, and with results which were to effect a complete revolution in the iron trade, and to have undreamed-of effects in many other directions.

Henderson, of Glasgow, had discovered a process by which he could produce a compound, subsequently known as ferro-manganese, which held more than double the quantity of manganese contained in the richest known spiegeleisen, although accompanied by a larger proportion of carbon. No one was found in Great Britain to appreciate and make use of this valuable invention, and in the end the patents were acquired by the Terre Noire Company of France.

In 1874 some of the directors of the Landore Company, Swansea,

had information that the Terre Noire Company was producing specially fine, soft, ductile steel, adapted to many uses for which ordinary mild steel is not suitable. After correspondence and fuller information it was decided that one of the directors (Mr. Chas. Liddell), the chemist (Mr. Arthur Willis), and the general manager (the writer of this article) should visit the Terre Noire works and investigate the new process. Circumstances prevented the writer from paying the intended visit. The report furnished by the visitors showed that the special metal was produced in the open-hearth (Siemens) furnace, and that its special qualities were largely due to the use of (what was termed) ferro-manganese, instead of spiegeleisen. It was determined to experiment at Landore with the new alloy, or compound, and half a ton of it was bought, at a cost of about forty pounds. It proved to contain about fifty per cent. of manganese. (To-day such ferro-manganese would not cost more than a tenth of the price of that first parcel.) Here, then, were the means of adding to the steel the necessary percentage of manganese with a restricted quantity of carbon, and thus the range of variation was still further extended in the direction of softness and ductility.

Thus far attention has been confined to manufacturing processes; now other influences must be considered.

The incessant rivalry between England and other countries necessitates ceaseless efforts to possess the finest, strongest, and most powerful ships, guns, etc., and fixes on the high officials of the British admiralty and war office serious responsibilities. It is essential that they be acquainted with the advances made in the various branches of metallurgical science, in so far as these affect the materials used in the construction of ships, etc.

This knowledge, to be complete, must extend to results obtained in foreign countries as well as at home. An apt illustration of the vigilant attitude maintained in these matters, and of the great service that may thus be rendered, is furnished by the following incidents.

In 1874 Sir Nathaniel Barnaby was chief naval architect of the royal navy. In that year he visited some of the dockyards of France, and "had an opportunity of seeing the iron and steel materials used in building the ships of war for the French navy." In March, 1875, he startled the home manufacturers by declaring, with regard to the steel they made, that naval architects had a "distrust of it so great that the material may be said to be altogether unused by private shipbuilders, except for boats and very small vessels, and masts and yards; and marine engineers appear to be equally afraid of it." He further implied that it was not equal to that supplied to the French yards.

But even with this latter material he was not satisfied, for, after detailing the regulations for its necessarily careful treatment, he said "that a material which needed such care in its treatment would stand but a very poor chance in an ordinary shipyard. I, for one, should feel very doubtful about a ship built of it for myself, unless I could see every plate worked." He concluded in words that have been often quoted, which, although they caused serious perturbation in some directions, yet furnished inspiration and encouragement to a better state of things: "The uncertainties and treacheries of bessemer steel in the form of ship and boiler plates are such that it required all the care which it has bestowed upon it at L'Orient to avoid failure. The question we have to put to the steel-makers is: what are our prospects of obtaining a material which we can use without such delicate manipulation and so much fear and trembling? We have gone on for years using iron plates which are a compound of impure irons of different and unknown qualities welded together imperfectly at the rolls. We want a perfectly coherent and definitely carburized bloom or ingot, of which the rolls have only to alter the form in order to make plates with qualities as regular and precise as those of copper and gun metal, and we look to the manufacturers for it. I am ready, for my part, to go further than the French architects have gone, and build the entire vessel—bottom plates and all—of steel; but I know that at present the undertaking will involve an immense amount of anxiety and care. We ought not to be behind any other country in this matter, and it shall not be my fault if we are."

In the spring of the succeeding year the writer was in a position to state that he had, on behalf of the Landore Company, waited on Mr. Barnaby, and offered to accept his challenge; that some time later that company had contracted with the admiralty to supply the steel to be used in the construction of the Iris and Mercury—two armed dispatch vessels to be built at Pembroke dockyard. He also exhibited samples of the material supplied, and described the severe treatment they had received, purposely much in excess of the admiralty requirements.

The test conditions which were at that time specified by the admiralty for ship material were the same as those still in force. They call for a tensile strength of not less than twenty-six or more than thirty tons (one piece in fifty to be subjected to this test) with an elongation before rupture of not less than twenty per cent. on eight inches of original length. The well-known *temper-bend* test was also to be applied to *every* piece of material supplied. At that time the writer was in a position to state that five thousand pieces of plate and angle had been submitted to the resident surveyor (Mr. J. H. Biles, now

professor of naval architecture in Glasgow University), and that none had been rejected for non-compliance with the tests, exacting though they were as to the quality of the metal.

It will readily be believed that, with the apprehension of anxiety and responsibility manifest in the words of Mr. Barnaby, the greatest care would be taken in inspecting and testing the materials; yet the writer has pleasure in stating that neither at that anxious time or since has he experienced arbitrary, irksome, or unjust treatment; on the contrary, there has always been a disposition to facilitate, in every possible way consistent with prudence, the satisfactory completion of contracts.

Looked at from the standpoint of to-day, when thousands of tons of such steel are made weekly without serious anxiety or trouble, it is scarcely possible to realise the anxieties and difficulties of that day; yet it is fair to state that to all those engaged in the manufacture of steel for that first contract it was no easy matter.

It may be borne in mind that, previous to the events we have been considering, it had scarcely been possible to obtain steel with a tensile strength of less than thirty-three tons; that, when the new admiralty test conditions were stated (a maximum strength of thirty tons), several firms declined to accept them, and one eminent firm ceased from that time to undertake the manufacture of steel plates.

In the writer's earliest experience in the study of this branch of steel manufacture, some months before entering into this contract, many experimental charges were made, which were unsuitable, as they had a tensile strength of thirty-one tons or more. It was therefore no light matter to enter into a contract calling for the supply of the *new material* on so large a scale that it must become one of the principal items of every-day work. However, by dint of careful selection of materials used, by care and skill in conducting manufacturing operations, and with the aid of ferro-manganese still richer in manganese, these difficulties were gradually obviated or overcome. In connection with the use of richer ferro-manganese it may be mentioned that, having appliances and means at disposal, the writer erected at Landore a small blast furnace (the first used for this manufacture, at all events in England), and produced from it at a reduced cost richer ferro-manganese than had hitherto been available. The contract was completed in a manner so highly satisfactory to the admiralty that it may be fairly said that there was a practical ending of the "fear and trembling" condition of mind, and from that day forward "mild steel" became the ordinary material used in the construction of vessels for the royal navy, as, indeed, it is, not only for warships, but for the mercantile marine of the world.

This narrative exhibits an interesting concatenation of circumstances paralleled, perhaps, at other times and in other industries, but scarcely capable of a more striking exposition than was afforded here. The admiralty were desirous of building better ships; the naval architect was in search of better material, appealing to the manufacturer for it and to some extent indicating not only what it should be, but how it should be produced; the steel-maker was seeking for some occupation for his plant different from the ordinary run of work; the solution of the problem was found in the production of a recarburiser rich in manganese, for the first time available; and, as a result, we have witnessed the production and adoption of a new material and the commencement of a striking revolution which, in its progress, was to affect many of our staple industries.

GREAT RAILWAY STATIONS OF ENGLAND.

By Thomas Cargill.

THE spirit of coöperation which is productive of results so excellent, both ethically and economically, in railway management and operation, is strongly manifest in England, and to it, in great part, should be referred a type of station different from those heretofore described in these articles, and distinct enough to merit a name of its own.

It may or may not be a junction station, but it may be properly called a joint station,—that is, a station used by two or more companies. Generally, though not always, each company has arrival and departure platforms for the exclusive service of its own trains, but, at the same time, there are certain parts—station buildings and offices—which are common to them all. An example of a joint station is represented in plan in Fig. 1,—the Temple Mead Station at Bristol, on the Bristol & Exeter line of the Great Western railway. As may be seen by reference to the plan, the station is essentially a *station de bifurcation*, and the central part of the booking office, as well as the refreshment rooms, are situated in the fork formed by the gradual convergence of all the tracks toward the metropolis. This station, for the purpose of description, may be conveniently divided into two parts, one comprising the straight portion assigned to the South Wales and the Midland departure platforms, and the other, which is on a curve, occupied by the up and down platforms of the great Western line, and the arrival and interchange platform of the Midland railway. The "straight" terminates in a dead end; the curve, which has a radius of 1,000 feet, runs through, and is 500 feet in length between platforms. A curve, even of very short radius, at the entrance to a terminal station, is of very little consequence from an engineering point of view, as the speed of both arriving and departing trains is very low. But, when, as frequently happens, such a curve is laid out at the approach to an intermediate station, a serious blunder is committed; for, while the trains which stop can pass it in safety at their reduced speed, and will therefore be in no wise affected, the mails and other fast trains, which do not stop at the station, must be slowed down, to avoid serious danger of derailment.

Fig. 2 shows an elevation of the exterior front of the Bristol Station, which, together with its central clock tower, its airy-like pinnacles, and its spacious covered ways, is by no means a bad example of combination of the useful with the beautiful. It faces the "Ap-

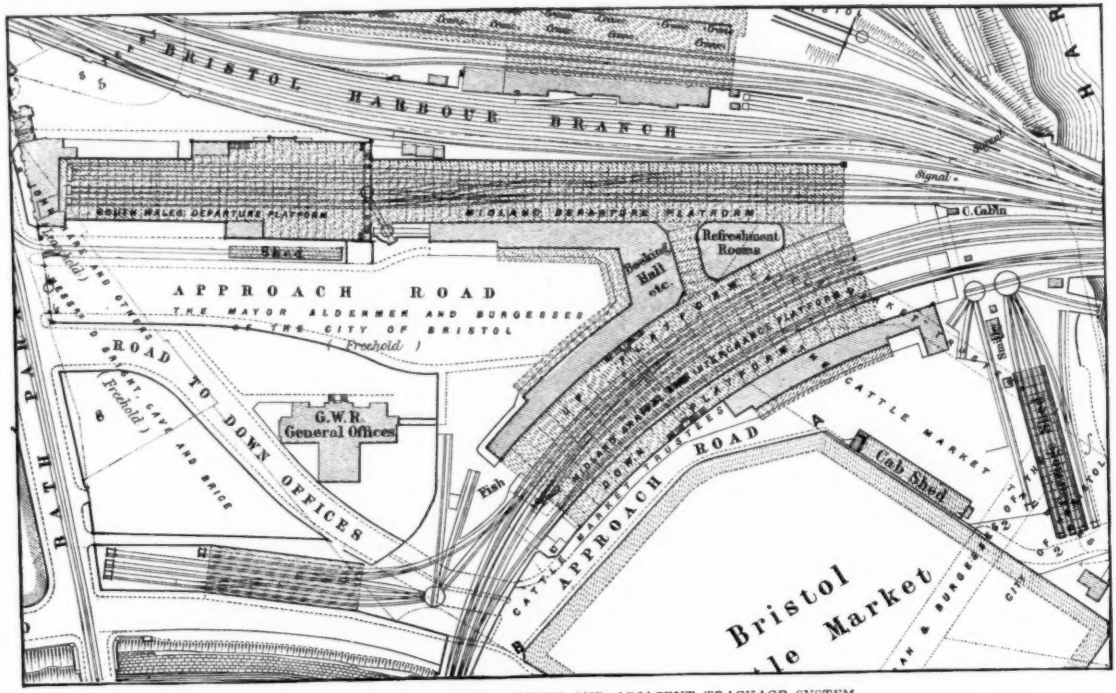


FIG. I. PLAN OF BRISTOL STATION AND ADJACENT TRACKAGE SYSTEM.

FIG. 2. GREAT WESTERN RAILWAY STATION AT BRISTOL, USED JOINTLY WITH THE MIDLAND RAILWAY.

proach Road," and has two wings, the one on the left communicating on the inside with the Midland departure platform on the straight part of the terminus, and that on the right with the up platform of the Great Western railway. The ridge and one of the sloping sides of the roof covering the curved part of the station are visible also, above the side wall on the right hand side of the photograph, so that it is a very simple matter to locate it on the plan. In the photograph in Fig. 3 is given a view of the interior of the station looking up the line; it shows well the general effect of the curve. One objection to a curved station, from a traffic manager's point of view, is that a very long train would not always be visible throughout its length from the guard's brakevan, and thus an extra hand would be required to start the train. Where possible, however, stations of all classes are built on the straight. The span of the Bristol roof is a hundred and twenty-five feet, and consists of a series of trussed arched ribs. As the walls of the station are not intended to take their thrust, the ribs are tied together by tie-rods extending from the one springing

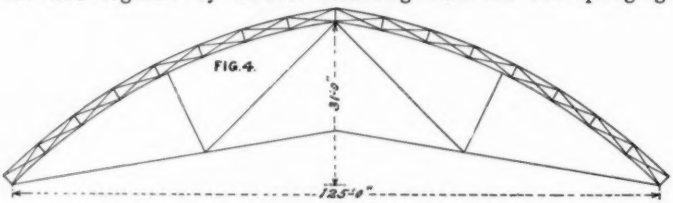


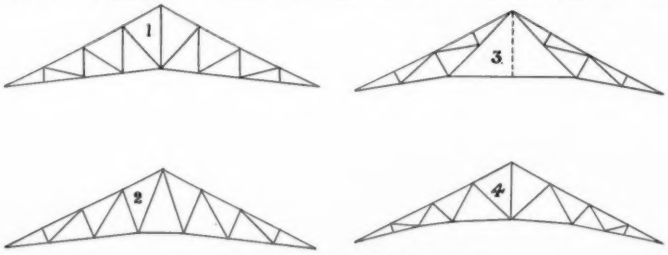
FIG. 4. SKELETON ELEVATION OF BRISTOL STATION ROOF.

to the other. Each tie consists of three parts, one central horizontal member, and two inclined side members. Light bracing is introduced between the ribs and the tie-rods, to prevent the sagging of the latter, but the ribs themselves are independent of any assistance from them. The trussing between the flanges is of the usual panel type, and, though one of the diagonal bars would be redundant under a purely static and uniformly-distributed load, yet, when it is borne in mind that the effect of high winds, and sometimes of storms, is often felt first on one side of a roof and then on the other, the necessity for counterbracing the web of the panels is at once apparent. Although not so severely scientific in design, to a professional eye, as the long-panel N type, the double intersecting diagonals in the arched ribs of the Bristol roof have a light and pleasing effect. The other system has a more or less lop-sided appearance, and always appears to want the additional diagonal member, which is inserted in all instances in two or three of the panels at the crown. A skeleton elevation of the roof of the Bristol joint station is given in Fig. 4.

FIG. 3. THE INTERIOR OF THE BRISTOL STATION, SHOWING THE CONSTRUCTION ON A CURVE.

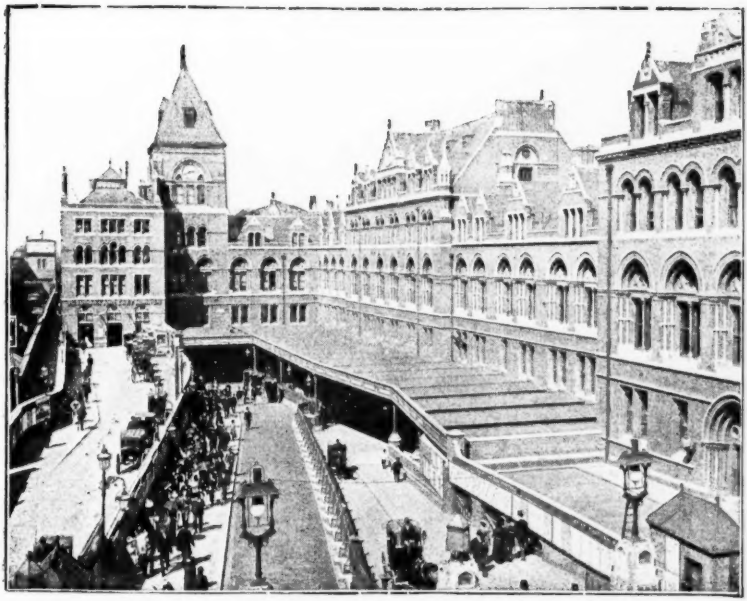
Attached to the passenger station, and at a short distance from it, are the locomotive, goods, and carriage sheds, coal stages and yards, and all the numerous houses, offices, buildings, and installations belonging to the *entourage* of great passenger stations and locomotive depots. The station is lighted on the intermediate principle, which diffuses the light more uniformly throughout the building than does either of the two others frequently adopted. The foot bridge can be reached by three flights of stairs, one on the up and one on the down platform of the Great Western, and the third on the Midland arrival and interchange platform. By means of the last platform and the foot bridge passengers by the Midland can find their way to the departure platform of the trains for South Wales.

The many forms of roof principals adopted for railway stations, with some exceptions, can be reduced to a small number of primary types or systems. Considering those built of either wrought iron or



ELEMENTARY FORMS OF ROOF TRUSSES.

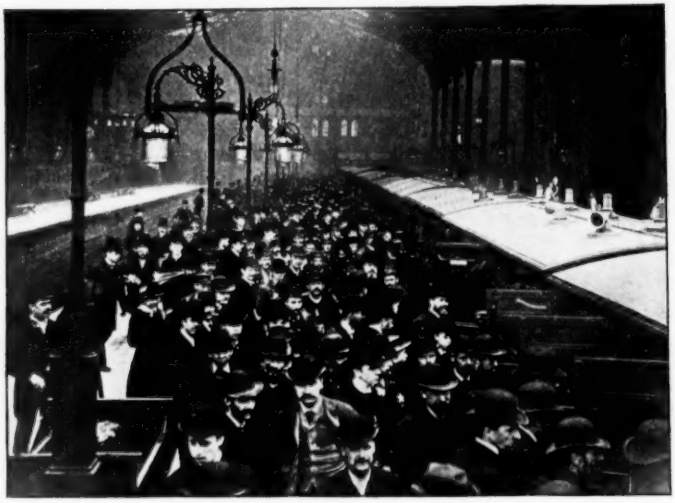
steel (in modern practice the latter material has almost entirely ousted the other) the principals themselves may be classed as those which resemble the ordinary rafter type and those which assume the arch form. In another roof, of a somewhat peculiar class, the principals are replaced by horizontal girders supporting the roof-covering itself, which is carried upon rafter principals of comparatively small span. This roof is also termed the ridge and furrow type. It has been adopted for the Bridge street station in Glasgow. A great railway station has not necessarily a roof of single span proportionate to the magnitude of the structure. In fact, several great English stations are roofed in by a succession of principals, whose dimensions are by no means commensurate either with the total area covered or with the importance of the station itself. In accordance with the title of this article, mention is omitted of all roof-designs suitable only for spans of less than sixty feet. Any of the rafter-shaped trusses, 1, 2, and 3, may be used for spans up to a hundred feet. Their general dimensions are the same, and they vary only in the manner in which the



EXTERIOR AND PART OF THE INTERIOR OF LIVERPOOL STREET STATION, THE LONDON TERMINUS OF THE GREAT EASTERN RAILWAY.

bracing is arranged. Whether one design, *cæteris paribus*, is more economical than another is doubtful, but the preference might be given to truss 3. It is known as the French truss, and may be used for rather longer spans than those which either of the other two examples allows. Neglecting the lengths of the rafters and the tie-rod connecting their extremities, or—what amounts to the same—regarding them as quantities common to all three designs, the total length of bracing in forms 1, 2, and 3 are as 3·7, 3·25, and 2.8.

Sometimes the tie is arched, as in example 4, which arrangement allows additional headway to be obtained at the centre of the span,



A PLATFORM IN LIVERPOOL STREET STATION.

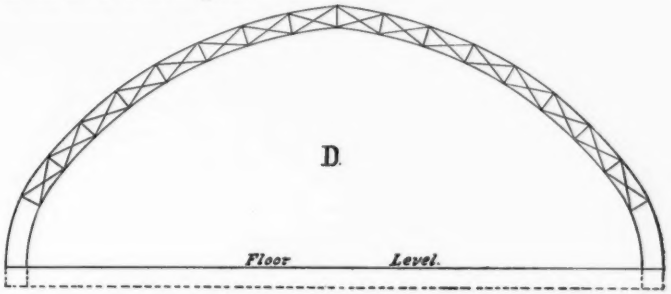
and tones down the rather stiff appearance of the three other specimens of the rafter or rectilineal system. One more example, 5, the shape of which resembles the old timber queen-post roof, completes the list of this class of roofs. When the span of a roof exceeds one hundred feet, it is more economical to adopt a semi-circular or segmental contour.

Under the next class are included the polygonal, the bowstring, and the simple arched rib, where intermediate trussing between the arch and the tie is introduced, as in the roof of the Bristol Station, solely for the purpose stated. All the different descriptions of bracing may be used in the first two of these last-mentioned types, except the

system represented in the French truss in 3. A polygonally-shaped truss, A, may have almost any description of bracing, and both the intradosal and extradosal lines may form parts of true curves. When this is the case, they are usually termed crescent, or sickle-shaped, roofs. The nearer the chord lines approach the circular, the more pleasing to the eye will be the general effect. When they depart widely from it, the truss, although a strong and useful one, becomes exceedingly unsightly, as scores upon scores of railway bridges testify.

POLYGONAL AND CRESCENT TRUSSES.

A comparison between the two patterns A and B will fully illustrate what they are intended to convey. The chief difference between the polygonal and the bowstring truss is that in the latter the upper chord is usually made part of a true curve. Either the circle or the parabola may be used, but the preference is generally given to the former, as the latter is not a graceful curve.



ARCHED ROOF, WITH HORIZONTAL TIE BELOW THE FLOOR LEVEL.

There is one other description of arched roofs, which to all appearance has no tie. It is not often used, except for very large spans, and is entirely unincumbered by any bracing of any kind between the crown and the springings. One of the most remarkable, and one of the largest existing, examples is the roof spanning the terminal station of the Midland railway at St. Pancras. The stretch from wall to wall is 240 feet, and the rise is 96 feet. The skeleton elevation, D, applies to all roofs of this character, allowing for different kinds of bracing in the depth of the arch. At Glasgow and Manchester, and in other large provincial cities and towns, this type of roof has been used for large spans of railway stations. In all large

arches of this character the horizontal thrust is provided for by a strong horizontal tie running across the station underneath the level of the floor; it may support the floor and everything on it.

It must be admitted that roof arches of the D type strongly resemble tunnels, and, in spite of the open web bracing, have rather a cumbrous, cavernous appearance. In this respect the roofs of St. Enoch's Station, Glasgow, and the Central Station, Manchester, appear to greater advantage than the example at St. Pancras. Instead of the peaked-pointed crown, the curve in their case is continuous at that point, although the radii of the central and side curves are different. What more than any other feature spoils the contours of all this class of arched ribs is the sharp bend introduced at the springings; but, as the walls of the stations must be built plumb, at any rate on the inside, it is difficult to see how the objection is to be obviated. In the accompanying table is a list of some of the largest arched roofs yet constructed, in which the ribs belong to what might be truly termed the invisible tie system. The largest arched rib

Name of roof.	Span in feet.	Rise in feet.	Date.
Manufactures and Liberal Arts Building, Columbian Exposition, Chicago	368	206	1893
Machinery Hall, Paris Exhibition	363	149	1889
Roof of Main Hall, Lyons Exhibition	361	108	1894
Station roof at Philadelphia	301	108	1893
	259	88	1894
Station roof at Jersey City	253	90	1892
St. Pancras Railway Station	240	96	1868
Central Station, Manchester	210	84	
Anhalt Station, Berlin	205	49	
St. Enoch's Station, Glasgow	198	80	
Horticultural Buildings, Colonial Exhibition	182	91	1892

erected at present is that at Müngsten, in Germany, for a railway there. It is built of steel, and has a span of 660 feet. The upper and lower members of the ribs are braced together by panel trussing, but there is no tie or any intermediate bracing, as the arch is firmly secured at the springings to the abutments. The Müngsten viaduct, with its gigantic central and numerous smaller side spans, presents an unusually imposing and striking appearance.

It seems to be an axiom that, the larger the site, or the greater the area, of a terminal railway station, the greater the number of tracks and platforms it can contain. As a matter of fact, the proportion is never direct, and in many instances is glaringly indirect. The absolute area, although unquestionably an important factor in the case, is not the sole consideration which dictates the methods to be

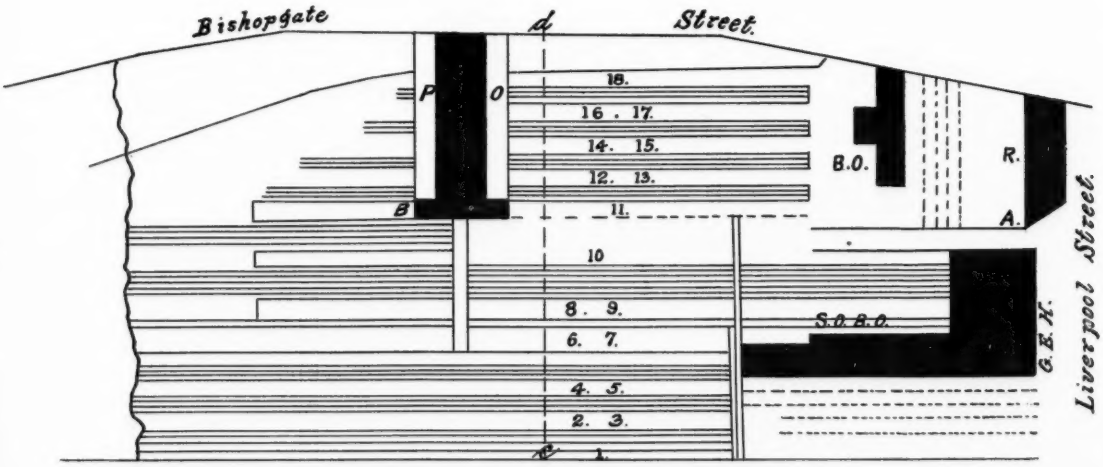


FIG. 5. BLOCK PLAN OF LIVERPOOL STREET STATION.

adopted to ensure the greatest facilities for carrying on the traffic. As with the planning—not the actual designing—of station roofs, so with the planning and setting out of tracks and platforms. The exact shape of the acquired site is a powerful element in the utilisation of its area to the best advantage. No doubt the shape of the site available must chiefly determine whether a terminal station shall be long and narrow, or short and broad, in plan. The metropolitan terminus of the Great Western, already described and illustrated, may be considered as belonging to the first class, and the Liverpool street terminus of the Great Eastern to the second, so far as relates to its breadth, which is sufficient for eighteen platforms, shown on the plan in Fig. 6. It is, however, only in the sense of purely relative proportion that it can be called "short."

Before analysing the distinguishing characteristic features of the Liverpool street station, a few particulars respecting its *raison d'être* and the great undertaking of which it is an important component part may be given. It was not until 1862 that the Eastern Counties became known as the Great Eastern railway, thus adding to its title the prefix enjoyed by two of its London neighbors, to which trio a fourth, also having its terminus in the metropolis, will soon be added, under the name of the Great Central railway. The extension of the Great Eastern from Bishopsgate into Liverpool street, together with the erection of the new and spacious station, was due to the inadequacy of the old station to meet the incessantly-increasing demands of the traffic, and to the recognition by the company of the fact that it must have a terminus nearer the city. The location of the station at Liverpool street, in the very heart of the city, is unrivalled, giving a tremendous advantage over all the other main lines. It is true that all these connect with the city—with the North London line in Broad street, for instance—and with the stations in the West end; but their headquarters remain on their primeval site. In reality, the present Great Eastern station consists of two stations,—the old one, and its extension.

Commencing at the left-hand side of the plan there are six tracks,—two each for the through, local, and suburban traffic,—which gradually bifurcate and ramify into a total of twenty alongside the various platforms 1 to 18, placed in the width of the station. It will be seen that every appliance and instrument required to work the traffic is numbered, and that the same numbers are very frequently, but not always, placed at each end of a junction.

If, in the block plan in Fig. 5, the line A B be drawn, it will divide the newer from the older part of the Liverpool street terminus, the platforms 1–10 belonging to the former and those numbered

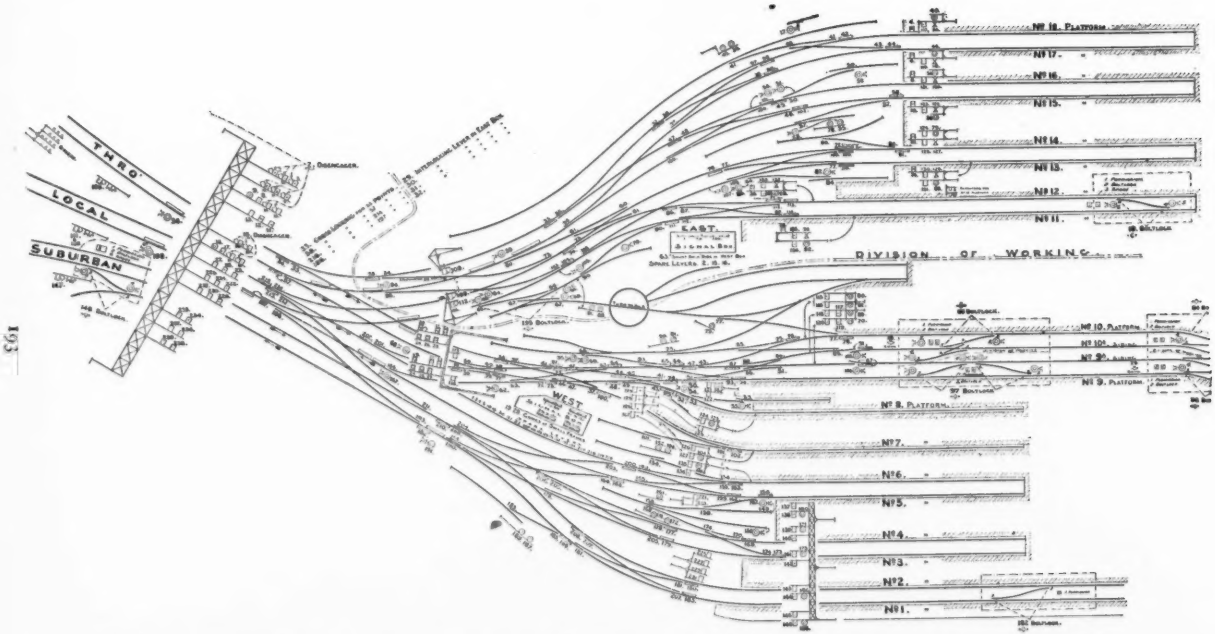


FIG. 6. PLATFORMS AND ARRANGEMENT OF TRACKS AT LIVERPOOL STREET STATION, GREAT EASTERN RAILWAY, LONDON.

11-18 to the latter. A reference to the dotted line in Fig. 5 will point out that "the division of working" follows pretty closely the same boundary, and that therefore, to some extent, the traffic arrangements are independent of one another, since all the signals on the one side of "working" line are worked from the east signal box, and those on the other from the west box. The main arrival and departure platforms are 9 and 10, and the manner in which the station buildings and general offices are situated with respect to them shows that the first part of the station was laid out on the compound principle. In the newer part, or extension, the dead-end system has been adopted, as indicated by the position of the booking and other offices. An especial feature in this terminus is the large parcel office, with an entrance in Bishopsgate street. It is built completely over the new part of the station, and communicates by a footbridge with the platforms on the opposite side. It is provided with hydraulic cranes, lifts, and all other necessary mechanical means, for lifting, lowering, and transporting the parcels, passengers, luggage, and goods which pour into it daily.

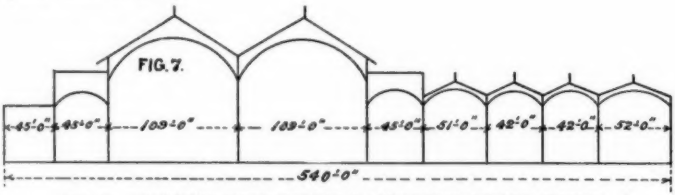


FIG. 7. SKELETON CROSS SECTION OF LIVERPOOL STREET STATION.

The skeleton cross-section, Fig. 7, along the line C D, in the block plan Fig. 5, shows at once the great breadth of the present station, and the manner in which the several spans are arranged. A noticeable feature comparatively, in the more recent construction, is that the length of the spans of the earlier part of the terminus have been just doubled. This is no doubt a considerable improvement, insomuch as it dispenses with some of the numerous columns required for the smaller spans, besides affording a greater unincumbered horizontal area, for the disposal of the tracks, for the working of the traffic, and for the comfort and convenience of passengers. In addition, the height is increased and the ventilation facilitated, and there is a sense of more space, light, and freedom of personal locomotion than can be experienced or enjoyed on platforms sheltered by roofs of small dimensions. No doubt the gradual advance made by engineers and architects, in largely augmenting the spans of both roofs and bridges, may have counted for something in determining the dimen-

sions of the roof of the station under consideration. Probably, also, the continual demands of the traffic were the chief factor in deciding the question. A subway leads from the terminus to the Metropolitan station, M R, in Fig. 5, on the opposite side of Liverpool street.

The photograph on page 187 gives an excellent view, looking down the line towards the parcel office, of the general *mise en-scène* of the interior of the terminus. It represents the wall, pierced with arches, dividing the old from the new part of the station, the two large spans of 109 feet each, and the smaller side span of 45 feet. It is evident that the roof principals are of the trussed rafter type, and, with the exception that the main tie is more arched, are identical with the form 4, in the illustrations accompanying this article. The principals are supported on columns thirty feet apart, and are connected by three rows of purlins, upon which small intermediate trusses are fixed, which carry the roof-covering, consisting of the tee iron and sash bars for the glazing, and timber sheeting for the remainder of the structure. The columns are placed in the centre of the platforms which are perfectly free from obstructions and fixtures. Another interior view, looking in the reverse direction, is shown on page 188.

Referring again to the six normal tracks, in the plan Fig. 6, to which all those within the area of the terminus ultimately converge, it is not so difficult as it appears to trace them to their respective arrival and departure platforms, in spite of the apparently confusing array of points, crossings, junctions, and sidings. In the first place it is to be observed that the direction in which the trains travel and the tracks to which they belong are shown by the arrows placed alongside the latter. Consequently, the outer, or further, "thro" track should end alongside the arrival platform of the main line, which is numbered 10. We may disregard the breaks in the plan, where the signals are shown, and, if we follow the track we have selected, it will be found that it is perfectly continuous until it terminates at platform 18. Its direction is known to be "up," because it and the track leading to the main arrival platform effect a junction at the points numbered 35, and could not therefore run in opposite directions. It will assist the reader, in tracing the course of any particular track, if he notes, when following it to the terminus, that junctions which take off in the same direction are frequently numbered consecutively. The "thro" departure line bifurcates at "57," and may lead to platform 17 or 9. Similarly the "local" arrival trains may pull up at either 14 or 6, and those departing may leave from 11 or 5. Platforms 1 and 2 are reserved for the "suburban" lines, which do not run into the new part of the station.

All platforms may be included in one or other of two divisions,

guarded and unguarded, or open and closed. By the former is meant a platform to which the public, whether passengers or not, have free access; the latter comprises those which are closed by barriers or gates, only travellers being allowed to pass. In terminal and through stations, where the booking office and other buildings are in direct communication with the platforms, it is almost impracticable to adopt the closed system, but it is a simple matter to use it in stations with a dead end. An open platform, with its refreshment rooms, book and newspaper stalls, and other conveniences, has a certain attraction for the public, especially for the idle portion of it. In the early days of railways, it was the custom on some of the great lines, when persons went to welcome their friends, or to see them off, to give them a pass for the platform, to enable them to do so. There is also a mixed system, which is very useful on through stations, when the booking office is either above or below the platform. The access to the platform is closed by a gate, which is opened only to those possessing a ticket, but at the same time book stalls, buffets, and the usual accessories are located along the platform. Nearly all the stations on the Metropolitan railway are arranged on this system, which works well. As a rule, the great railway stations of England have both open and closed platforms. I am not aware of an instance in which there is not one or more open platforms. There is sometimes much inconvenience to passengers, when the platform is situated between a pair of tracks, on account of the possibility of entering the wrong train, and even the occasional misdirection of the enquiring traveller. The remedy of a second examination of tickets, after the passengers have entered the carriages, entails extra labor upon the officials, and is seldom resorted to. In stations with open platforms, however, the chances for confusion and mistake are far greater.

At terminal stations laid out strictly on the dead-end principle, all the offices and station buildings are arranged along it, at right angles to the tracks. This is decidedly the more modern, and the best, system, for, while it allows a certain area for outsiders to benefit by all the advantages attending a large station, it debars them from crowding on the platforms and interfering with the comfort of those who, strictly speaking, alone have a right to use them.

ESSENTIAL PRINCIPLES OF ECONOMY IN STEAM-POWER INSTALLATION.

By W. Cooper.

THE striking tendency of the age is toward the reduction of the cost of production, and, whether the thing produced be substance or force, this reduction is to be secured by an intelligent and exhaustive study of each detail which enters into the organization of the whole.

When such an analysis is applied to a power installation, it is proper to begin at the coal pile, for this is the source of the power as well as the measure of all expense. Other things being equal, the more coal burned the larger the installation becomes, and the greater the fixed, as well as the operating, expenses.

The first thing to take into consideration, in connection with the fuel problem, is: what kind of fuel will evaporate the greatest amount of water per unit of cost under the most favorable conditions? Since the water in the boiler is evaporated by the heat evolved by the combustion of the fuel, it is important that this process of combustion be made as perfect as possible, provided it does not cost more to make it perfect than would be lost by allowing it to be imperfect. For instance, it would not pay to install a mechanical stoker if the interest on its cost and the expense of its maintenance would amount to more than the saving in fuel and labor effected by its use.

The first step in investigating the fuel is to determine the amount of heat in a given quantity; the second, to ascertain what part of this heat is absorbed by the water in the boiler. The first determination is the more difficult of the two, and can be effected only by chemical analysis or calorimeter test—preferably the latter. The second is easily computed from the number of pounds of water evaporated.

If it be found that only fifty per cent. of the heat in the fuel is accounted for by the heat in the steam, the conclusion is that some of the heat is not evolved, owing to imperfect combustion, or else is lost after evolution. The question of the perfection of the combustion can be solved, with a greater or less degree of accuracy, by observation. If the heat is lost after being evolved, the fact can easily be determined by taking the temperature of the flue gases and the outside brick work, etc., of the boiler settings.

If combustion be perfect, all the heat should be accounted for by the three following measurements,—*viz.*, the amount radiated from the

boiler and settings, the amount passing up the stack, and the amount absorbed by the water in the boiler. This last part only is doing useful work. The amount of heat radiated from the boiler and settings, except in very extreme cases in which it is easily detected, is small, and may be neglected in these calculations without introducing any great error.

The temperature of the flue gases is easily taken with a pyrometer, and should be but little above the temperature of the steam in the boiler. It is evident that the gases cannot be delivered at any lower temperature than that of the steam, but their temperature should be little higher. The only way by which any more heat can be taken from the flue gases, lowering their temperature below that of the steam, is to bring them into contact with the feed water, in some kind of a so-called economizer, after they issue from the boiler.

If, after examination, it be found that the temperature of the flue gases is but little above that of the steam,—say not more than 50° F.,—and the radiation from the boiler and settings be not excessive, and still the heat be not absorbed by the water in the boiler, there is only one source to which to attribute the difficulty, and that is imperfect combustion. The first thing to take account of is the amount of combustible taken from the ash-pit. If this be found in large quantities, the firing is not properly done, the cause possibly being bad condition of the furnace. If the amount of combustible in the ashes be small, or if there be none at all, then the fuel goes up the stack unconsumed. There are many reasons for this.

Complete burning of the coal means perfect combustion. When a chimney discharges smoke, it is evident that the combustion is not perfect. If the combustion be not perfect, it is proof positive that insufficient air has been admitted to the furnace or combustion chamber, or, if sufficient air has been admitted, that the temperature at which it mingled with the solid or gaseous fuel was not high enough for oxidation.

The usual process of burning coal in the furnace of a steam boiler involves both distillation and combustion, and at almost all times some part of the furnace is below the temperature of combustion. The fresh fuel is usually delivered to that part of the furnace to which no air can penetrate without first passing through highly-heated portions, in which the oxygen is consumed. The heat of these products of combustion, however, distills off or sets free the volatile portions of the fresh fuel, and, as there is no oxygen with which these can combine, they pass off unoxidized. In order to produce perfect combustion, the volatile portion of the coal, which is set free by the first application of heat, must be brought into that part of the furnace

which is at, or above, the oxidizing temperature, and it must be mingled simultaneously with sufficient air to cause complete oxidation.

With a furnace so constructed that these results could be effected, the problem of getting the heat into the water in the boiler would be much simplified, since the efficiency of the heating surface would not be impaired by the presence of soot.

In general, if the efficiency of a steam boiler is not what it should be, the first thing to do is to find if the cheapest kind of fuel, obtainable in proper quantities and applicable to the conditions, is being used, and if it is all being burned. If this be found to be the case, there is but one question more, and that is: Does the heat of combustion get into the water in the boiler, or does it go up the chimney, or out through the brick work, or elsewhere where it is not useful? When the three conditions of cheapness, perfect combustion, and complete utilization are fulfilled in the highest degree, the highest efficiency is reached.

It is practically impossible to fulfill these conditions by hand firing, and in but few of the mechanical stokers on the market are they even approximated.

From the foregoing comparisons ideal conditions can be formulated for the boiler plant. The first of these conditions relates to the handling of the coal and the manipulation of it under the boilers. It is evident that there must be a balance between the interest on the investment in mechanical appliances and the cost of labor for hand-firing. In the stoking of coal, however, there is another factor to take into consideration. The installation of mechanical stokers reduces not only the labor item, but the fuel item as well, through the more perfect combustion which is secured. The extra plant may, however, so increase the interest and maintenance item as to overbalance the saving in labor and fuel.

If properly installed, coal-conveyors and mechanical stokers are, in a great majority of cases, an economical investment. Where the coal is of poor quality, and, in consequence, larger amounts have to be used, machinery of this character is especially likely to prove economical, because it displaces so much hand labor. On the other hand, if the coal be of very good quality, the labor of handling might not be great enough to warrant using machinery.

An arrangement of boilers which conduces to economical handling of the coal is in two rows of batteries, two boilers opposite and facing each other in each battery, with coal storage above and through the center of the building, leaving all the space above the boilers, on both sides of the coal bins, free for steam and other piping. The

coal is taken by chutes from the main storage bins directly to the mechanical stokers. Under the boilers a continuous channel with a conveyor delivers the ashes into a car. In this arrangement absolutely no hand labor is required.

Now that ideal conditions for handling the coal and burning it under the boilers have been determined, and means pointed out for approximating them, the next step to be considered is the utilization of the heat of combustion.

The efficiency of a boiler should be determined on the percentage of the heat units in the coal absorbed by the water in the boiler, and not by the number of pounds of water evaporated per pound of coal. The best method for determining the heat units in the coal is by calorimeter test, as this gives the heat by actual combustion and not by intricate calculation from a chemical analysis. The calorimeter test should be continuous, and should be made under the same conditions as the boiler test. This means that it must be made on the ground, at the same time as the boiler test and for the same period.

There is but little difference in the efficiency of different types of steam boilers when properly set and equipped. The value of the calorimeter test in this connection is to determine whether or not these conditions of setting and equipment have been fulfilled. The difference in the actual value of different boilers lies in their capacity per unit of cost and maintenance. This statement means that any boiler can be made to show the maximum efficiency. The conditions of maximum efficiency are that the combustion shall be perfect, the flue gases shall escape at exactly the temperature of the steam in the boiler, the radiation factor be reduced to a minimum, and the ashes be drawn at the temperature of the entering air. When these conditions are fulfilled, one boiler will show no higher thermal efficiency than another. Any boiler can be made to meet these conditions *at some capacity*—and therein lies the chief difference in steam boilers. Their comparative capacities, at maximum efficiency per unit of cost and maintenance, measure their comparative values, other things (such as safety, etc.) being equal. This being true, the points to be determined are: what is the proper setting, and what is the capacity at which any given boiler will show the maximum efficiency?

Thus it is seen that there are but two points to consider in the selection of a steam boiler,—cost, and maintenance per horse power at the capacity at which it is guaranteed to reach the maximum efficiency. The above conclusion takes into consideration only the actual expenses,—that is, the fixed expense of interest on investment and the expense of maintenance. There may be other considerations entering into the question, which will alter the decision as to the boiler to

be selected: such considerations are safety, maximum capacity or ability of the boiler to stand forcing, etc.; but these have no direct bearing on the actual question of expense. Under the item of maintenance is included cost of cleaning, repairs, and renewals, and such other operating expenses as would not be identical in all kinds of boilers. Under the item of cost must be considered the space occupied, for that enters, as a direct factor, into the cost of the building site.

The designers of steam plants usually commence to duplicate at this point, in order to provide against so-called accidents. They often spend thousands of dollars to duplicate boilers, steam piping, and engine, while they do not provide storage for fuel enough to run the plant twelve hours, even when, as is often the case, they are dependent upon a single line of railroad for their supply.

There are but few accidents in power plants. Ninety-nine per cent. of the so-called accidents can be traced to ignorance or carelessness. If a boiler bursts, it is due either to the ignorance of the men who designed it or to the carelessness of the man operating it. It is wiser to secure the margin of safety by increasing the strength of the parts than by increasing the number of parts.

Since the energy in the steam, in the form of heat, was produced by the combustion of the fuel, it follows that every unit of heat which would otherwise go to waste, that we can put into the feed water, is clear saving. There are but two sources from which waste heat can be recovered,—the flue gases, and the steam after it has partially or wholly completed its work in the engine. In considering the value of the first, the second must also be taken into consideration.

If the plant be run non-condensing, the installation of an economizer is little better than useless. If the plant be run condensing, a heater of the proper design introduced just ahead of the low-pressure cylinder gives better results than an economizer. Probably under no considerations, with the flue gases at the proper temperature, can an economizer be made to operate as efficiently as a heater using the latent heat of the steam from the engine at about atmospheric pressure. There is another method of heating the feed water in condensing plants, using the latent heat of the steam, by introducing a primary heater in the exhaust from a condenser. As the temperature of the exhaust is but little above that of the hot-well, it is evident there is not much saving to be made. Heating the feed water by steam taken from the low-pressure receiver is much more economical than pumping the water directly from the hot-well into the boiler. The reason is that steam which has performed work is again used, and all the additional work so secured is clear saving. It is possible to make a saving by using a heater between the consecutive cylinders in com-

pound engines. By this arrangement there would be as many heaters as cylinders in non-condensing engines, and one less than the number of cylinders in condensing engines. It is common practice to take water from the hot-well and pump it through some kind of a heater, either open or closed, in which it is brought into contact with the exhaust steam from the feed pumps and the other non-condensing "steam suckers" about the plant. The heat derived from this source is usually enough to raise the temperature of the feed to a point between 150° and 180° F. The statement is often made that there is no need for any heating of the feed water beyond that secured by using the exhaust from the pumps, for this alone will raise the temperature near to the boiling point. A feed pump that will heat the water with its own exhaust is just what is *not* wanted.

A duplex steam pump requiring from one-hundred-and-fifty to four hundred pounds of steam per horse power per hour is certainly not an economical machine by which to feed a boiler, when there is an engine, running right beside it, that requires only from fifteen to twenty-five pounds. A duplex steam pump is an emergency machine, not a constant-service one. In no plant that makes any pretence to economy should a duplex steam pump be allowed, except for use when the main engines are not running.

In a condensing plant where the condenser is, as it should be, driven by an engine of economical design, the feed pumps may be conveniently run by the condenser engine. If the condenser is direct-driven from the main engine, which is better still, the feed pumps may be run in connection with the condenser or, more conveniently, driven by belt or electric motor. In no case should a duplex steam pump be used when it is possible to connect with the main engine. An electric motor makes a very convenient arrangement, since, if there is an engine running in a railway plant, there is usually current to be had.

Great care and much money are expended in many plants in making the steam piping fully duplex. Seldom, if ever, is the feed-water piping made duplex, and often it is what might be called less than single.

It is more important to make the feed-water piping duplex than it is to duplicate the steam pipe, for water-pipe connections are subject to shocks to which steam pipes are never subjected, for the obvious reason that non-compressible or inelastic fluids are more difficult to handle without shock than those which are compressible and elastic. Great care should be taken in the construction of the feed-water machinery and connections, but in no instance should it be necessary to install a full duplex system of feed-water piping.

The impurities in the water, such as the sulphates and carbonates of lime and magnesia, should be removed before the water enters the boiler. Never feed a boiler at a point requiring the water to pass over fire surface before it reaches the temperature of the steam. It is during the process of heating that the sulphates and carbonates are precipitated, and, if they are precipitated while the water is in contact with a hot surface, they will form on that surface as scale of the worst kind. If, on the other hand, they are precipitated away from contact with a hot surface, they will be carried in suspension in the water and circulate with it to a greater or less extent, settling in those parts of the boiler where the circulation is less rapid, and the water consequently the coldest. It can make no possible difference to the steaming of the boiler whether the water is fed into the steam space or at the mud drum, as no more units of heat are required to bring it up to the temperature of the steam in one place than in the other.

A single connection to a boiler, properly made, is as thoroughly reliable as any part of the whole equipment. Arrange the feed pipe, as stated above, in such a manner that the cold water, (it is cold if below the temperature of the steam) will not come into contact with the hot metal surface. Put a heavy, brass-bodied check-valve, of the swinging clack or ball type, immediately inside the boiler, with another immediately outside, in series with the inside one, connected by a short XXX nipple to a heavy, iron-bodied, asbestos-seated, plug cock. Then use extra-heavy iron pipe, heavy brass elbows and tees, and heavy flanged unions, *not* couplings. Each boiler is to be connected to a single header of the same size as the boiler connection, using brass elbows and tees throughout. This header is run to the feed pump.

If this header is found to be insufficient for all of the boilers, it can be supplemented by another of such a size that the combined area of the two will be sufficient; the supplementary header should be connected to the main one at two or more points, according to the number of boilers, but it need not be connected oftener than once for every two boilers. This supplementary header can be made of common pipe and fittings, and reduced in size as it advances. Each cross connection between supplementary and main header should be provided with a good gate valve, and a good gate valve should be introduced in the main header between each pair of boilers. In all of this piping, ample allowance must be made for expansion, but no expansion joints should be used.

There are two kinds of feed-water heaters, the open and closed. An open heater is one in which the water comes into direct contact

with the steam; in the closed the heat of the steam is transmitted to the water by convection, the water being on one side of a metal sheet, or tube, and the steam on the other. The advantage of the open heater is that the water can be relieved of a portion of its impurities while it is being heated, as most of the carbonates and some of the sulphates are precipitated at or below 212° F. If suitable arrangements are made, the precipitated impurities can be removed. One of the disadvantages of the open heater is that it necessitates the pumping of hot water, which is troublesome if correct conditions are not secured; another disadvantage is that a portion of the oil used in the engine cylinder is liable to become entrained in the feed water and cause trouble in the boilers. If the proper oil is used, this condition does not occur in ordinary practice. The advantage of the closed heater is that the feed pump has to handle only cold water, and no oil can mingle with the feed; the disadvantage is that, if any of the impurities in the water are precipitated, they form scale on the surface of the heater, and very soon impair its efficiency. An open heater, properly constructed and manipulated, gives far more satisfactory results than a closed one. Its efficiency never becomes impaired, and its cost and maintenance are much less.

It is common practice to construct and erect feed-water heaters so that all of the exhaust steam from non-condensing engines will pass directly through them. This is obviously unnecessary, as, with the coldest feed water, not more than one-sixth part of the steam will be condensed. In a closed heater it is a positive disadvantage, as it necessitates the use of a heater of much greater area of opening than would otherwise be required. In an open heater this does not hold true to so great an extent, as the construction is simpler and the heat of the steam is largely taken up by the water while in the form of spray, which offers very little resistance to the passage of the steam.

There is a cardinal principle that is often lost sight of in steam engineering. Steam cannot be cooled down, or the temperature of steam cannot be lowered, without lowering the pressure, unless the steam has been superheated. This condition is, however, found frequently in ordinary practice, and must be taken account of, as it is a source of considerable loss. In the case of an engine with steam-jacketed cylinders and receivers and a large amount of free expansion at the exhaust there may be a good many degrees of superheat. Allowing the steam to be exhausted from the engine superheated, and then introducing a heater especially adapted to utilize it, is on a parallel with allowing the flue gases to escape at a high temperature and installing an economizer to save that waste.

In considering the question of feed-water heaters it must be assumed that the steam is simply saturated. By saturated steam is meant steam the temperature of which corresponds to the pressure it would have if in contact with water, and not steam that is "saturated with water," or wet steam in any of its various stages of "saturation." Therefore, if the steam be in such a condition that, if heat be taken from it, some of it will be condensed, it is necessary only to keep the heater full of steam to maintain the maximum obtainable temperature.

Feed-water heaters for non-condensing engines should always be erected with a by-pass, of sufficient area to carry all the exhaust steam, provided with a valve by which the flow of steam through the heater can be regulated to suit the amount of water passing. This arrangement also enables the heater to be cleaned while the engine is running. Feed-water heaters arranged in this manner become practically what are known as vacuum feed-water heaters, or purifiers, except that in that class of heater no provision is made for allowing any of the steam to pass through the heater, all that enters being condensed by the feed water.

The so-called vacuum heaters are simply closed chambers, connected to the exhaust pipe, and the vacuum is that necessary to overcome the resistance to passage of the steam from the exhaust pipe to the heater. If the apparatus be properly erected, this resistance is very small. This class of heaters may be either open or closed, and can have no possible advantage over any other class of these two types in point of principle of action. The claim is made that the impurities in the water separate more readily in a vacuum than under pressure. The fact is that, for purifying the water, a heater under atmospheric pressure is as much better than a vacuum heater as the temperature in it is higher, and a live-steam purifier is as much better than an atmospheric-pressure heater as the temperature in it is higher, for the reason that the impurities precipitate more and more completely as the temperature goes higher.

As before stated, the prime office of a feed-water heater is to heat the feed water. A heater that does not do this is a failure to just the extent that it fails to attain the maximum temperature. This may be due to either or both of two reasons: the extent of surface may be insufficient, or the surface may have become inoperative. It is often found in closed heaters that they heat well when new, but soon fall off in efficiency; this is due to the surface becoming coated with scale precipitated from the water,—a condition that should not be allowed to exist. In the selection of a feed-water heater there are two points to be considered: (1) the water must be heated; (2) the water

must be freed of all the impurities that will precipitate at the temperature to which it is heated. A feed-water heater that does not fulfill these conditions, to within a very small per cent. of the possible, should not be retained; for nowhere else in the whole plant can so large a saving be made, by the same expenditure of money, as in the utilization of the latent heat of exhaust steam. Therefore, the heater that will fulfill these conditions at the minimum expense for interest and maintenance is the heater to select. It often happens that a heater does not reach its minimum efficiency until it has been in service for a considerable length of time, and any test made to determine its efficiency soon after its installation is liable to be misleading. There is another condition that must be fulfilled, which goes without saying—the heater must not produce any back pressure on the engine piston. In order that a feed-water heater may heat the water to the temperature of the steam, the transmission of the heat from the steam to the water must be perfect; that is, the resistance to this transmission must be zero. This is a very difficult point to reach, and can only be approximated in a closed heater by having a large extent of surface and keeping that surface clean. In an open heater it is necessary only to divide the water into a fine spray; the heating can be done in a very small space. A closed heater is analogous to a steam boiler, the steam taking the place of the flue gases the heat of which is to be transmitted to the water, and is subject to the same conditions. In order that the temperature of the flue gases or the steam may be brought down to that of the water, the extent of surface must be very great, and, before this balance is arrived at, a point is reached where an increase in the extent of the surface means a loss, on account of the destruction of the balance between the saving made and the interest on the necessary investment.

EFFECTIVE SYSTEMS OF FINDING AND KEEPING SHOP COSTS.

By Henry Roland.

HITHERTO these papers have dealt chiefly with the means adopted by various factories for obtaining flat, or prime, cost, made up of the costs of material and of labor.

There are costs of factory production other than those of labor and material, and these are commonly included in the general term of "expense," as distinguished from "direct-production" costs.

In point of fact, there is no real difference between the separate component parts of the total cost of factory production and the costs of material and of labor, which are generally spoken of as making up "prime-cost" of product, are no more primal, or first, costs of production than those which go to make up the expense account.

There is, however, this difference between the material-and-labor cost of factory production and the other elements which go to make up the total cost: the material-and-labor costs are current items, and must be paid for, in cash, at frequent set intervals, while many of the items commonly carried to the expense account arise from permanent investments of capital, and do not involve the disbursement of monies at any set time. Hence, as it is an innate fallacy of the human mind to ignore obligations grown old, it is not uncommon to find systems of factory accounting which fail to recognize some of the first-made elements of factory expense. Thus, although the factory buildings are highly important, and in many cases costly, elements of factory production, some large factories wholly ignore the building in the cost accounting. Other items of magnitude are denied as proper sources of expense by some accountants, while fully recognized by others.

There is also a personal element which can, and does, lead to material discrepancies in different formations of the expense account. Labor and material are commonly held as fixed in price, for the time being, by causes beyond the control of the general manager, while the expense account is generally regarded as being diminishable through superior management; hence there is plainly visible, in some systems of shop accounting, an attempt to keep the expense account small on the books. It is hardly needful to say that the first object of a system of factory-cost accounting is to record absolutely correct information, and that evasion or subterfuge of any sort is intolerable in this connection. A factory, from an economic point of view, is in-

debted for every dollar of its cost, and no factory indebtedness can ever be legitimately extinguished in any way except by its own factory earnings. From this point of view a factory cannot take a gift; if, through some peculiar combination of circumstances, a manufacturing enterprise obtains its realty and buildings without cash expenditure on its own part, the interest on the original value of the realty and improvements is, nevertheless, chargeable to the expense account, since a wide economic view cannot tolerate the infringement of general rules because of abnormal special conditions. If the factory does not pay for its ground and buildings, some one else does, and interest on this outlay is justly an item of the expense of the products of that factory.

There are two objective points in cost keeping. The first is the determination of a price at which the factory production can safely be offered on the market; for this purpose, gross sums suffice. The second point sought is lessening of production costs, and, to obtain this highly desirable result, the most minute attainable subdivision of cost is demanded. Hence, in all cases, the beginner in cost keeping is inclined to open as few accounts as possible, because gross amounts will serve his first purpose of discovering a safe selling price, while the experienced cost keeper will subdivide his expense account even down to ultimate items. This may appear, at first sight, to be a mere slavish regard for minuteness of detail; it really arises from his knowledge that production expenses cannot be reduced in gross, but must be attacked in small parts. A manager cannot reduce expense by notifying his subordinates of his general desire to do so; he must point out the exact items which shall be lessened, and before he can specify any reduction, at any point, he must know all the component parts of the cost of that detail. Hence, the experienced cost keeper may divide the expense account into a hundred, or more, subordinate accounts, while the inexperienced cost keeper may keep his expense in a single account, or, at most, divide it under a very few heads.

The general factors of the expense account are, in chronological order of creation, as follows: first, the earning power of the man or men who are to be the owners of the factory; this item may vary, evidently, from the mere day wage of the artizan who starts in business for himself, with himself as sole manager and operative, up to any sum whatever, as in the case of a man having the highest qualities of business foresight and executive ability, who rises from no position or income to a yearly earning of tens of thousands or hundreds of thousands of dollars. After the master comes the shop; the interest on the investment of cash, or credit, in realty and buildings becomes a charge to the expense account, together with taxes, assess-

ments, a certain percentage for deterioration, and the various maintenance items pertaining to the structural property used as the factory. Then follows the plant, or equipment, item, which creates another series of interest, depreciation, and up-keep items chargeable to the expense account. Then follow lighting, heating, watching, insurance, and so on—all of the expense account so far going directly to provide a suitable theatre for the exertions of the workmen, who are commonly regarded as the direct first agents of production.

The introduction of the human element into the problem of factory production involves the indefinable factor of sympathy. In dealing with material values justice alone is demanded. Hence, there is no difficulty in laying down hard and fast rules by which accurate applications of the expense account may be made, up to the point where the human element involved by the introduction of the workman appears. The factory owners are also human,—are often, in point of fact, deserving of sympathy and consideration,—but they are free agents, potentates, men of might and substance; hence they, too, may, as factory owners, be held as rightfully demanding justice only, the same as the capital which they use or the factory products which they create.

Not so with the workman. We may number our artizan, mark him and tag him, and rank him in shop accounting with the insensible agents of factory production; but all of this will not do. We feel that he is human—a creature of hopes and fears, joys and sorrows, not to be safely, or justly, or wisely, classed with the inanimate engines of production which the factory employs. The workman must have sympathy, and sympathy is not a generally recognised commercial element; yet sympathy for the workman very often successfully opposes the dictates of the expense account.

It is not the intention of the writer to formulate any theory, or enter into any argument; still less is it the intention to print a merely superficial view of the expense account such as is involved in the marrowless statement how and when the items of the expense account are created. The manufacturer is interested in the reduction of the expense account, and in having this expense account, which he must in all cases pay himself, paid back to him by his customers.

To make my meaning unmistakable, the following commonly-accepted industrial definitions are given:

Labor: animal effort. All labor, no matter by what animal performed, is both muscular and mental, proceeds from volition, and must be recompensed by sustenance if it is to be continued. In general, continuance is implied in and by the words industry, industrial business, work, and labor.

Laborer, or workman: one whose recompense is measured by the time-duration of his muscular effect; one who directs his own animal effort only, as distinguished from one who directs and recompenses the animal efforts of others.

The distinctive feature of labor or work, as compared with all other things of value, is evanescence. Labor recompense and labor value depend upon a time-duration of effort, and are wholly lost if the labor is not performed from minute to minute as time passes. The flight of time is unchangeable; hence labor is the most certainly perishable of all perishable values. The laborer must always form the undermost element of the industrial structure—governing nothing, dominated by everything, because he is dependent for the continuation of existence on the sale of a thingwhich is forever lost if not sold from minute to minute.

Between the workman and the factory there is always an unwritten, but fully acknowledged, contract of good and faithful service on the part of artizan, and of continued employment on the part of the factory. The factory is willing to take a boy at an early age as an apprentice, teach him the trade, and continue to furnish him employment during all of his life. This of course includes the natural perpetuation of the workman by reproduction, and thus makes the factory the support and dependence of the workman and those dependent upon him. The married workman is more "reliable" than the unmarried, and the family is encouraged by the wise factory manager. The factory which, from any cause, cannot furnish employment for its workmen takes the ignominious position of an industrial bankrupt. Nothing can be more humiliating to a manager than the statement to a satisfactory workman that there is no longer work to keep him busy, and that the workman must either find employment elsewhere, or must remain idle until the factory obtains more orders.

Money: concrete labor, or labor transmuted into a tangible and permanent form, which may be handled, transferred, exchanged, and stored without extinction and without regard to the passage of time. Nothing except labor can produce money, and the labor duration required to produce money is invariably the measure of the value of the money so produced. Gold is the most suitable substance yet discovered for use as money, because its rarity makes constant for short periods of time the total labor needful to obtain an ounce of gold, or, in other words, makes sudden fluctuations in the value of an ounce of gold impossible. The fact that gold is constantly becoming cheaper is of no practical importance, because the change is so gradual that we have time to adjust the machinery of trade to the diminution of the labor-value of the gold ounce.

Admitting that money is concrete labor, it must of course have an earning power, as labor has, in addition to its peculiar attribute of imperishability; it is consequently master of everything by virtue of its immortal power of earning, precisely as labor is the servant of everything because it dies from instant to instant and lives only in the inappreciable fraction of duration which forms present time.

Capital: accumulated labor.

Industrial capital: accumulated labor engaged, at least partly, in the recompensing of labor for its time duration.

Factory: a building erected by capital for use in the production of some article for sale in the open market, in competition with similar articles produced by other factories.

Factory plant: everything placed in the factory building to assist labor in the production of salable output.

Accepting these definitions, which are those sanctioned by all recognized authorities on factory economics, it follows at once that no investment of industrial capital can be neglected in the expense account, because money never loses its power of earning. The production-expense account is made up of interest, taxes, and assessments on realty, insurance, interest, and depreciation on plant, all non-productive factory labor, and, in short, every outlay caused by the factory, except the labor and material used directly in the production of salable articles. This is the extent of factory expense proper, and it is not uncommon practice to make a division in accounting here, transferring the finished factory product to the commercial side of the concern. This procedure simply separates the making and selling sides of the business. If no such separation is made, the factory expense includes also advertising, travelling, and good-will expenditures, and commercial book-keeping—expenses which, in the divided system, are charged to the expense account of the commercial department. The expense account and the prime-cost or production account must, together, include all expenditures and liabilities incurred in carrying on the business, including the earnings of owners.

Several different methods of distributing the total of the expense account are in use. The factory expense may be divided by the total cost of the productive machines forming the major part of the plant, thus giving each productive machine an individual hour rate. This method is faulty in case of an idle tool, as it leaves a part of the daily expense unaccounted for. The more common method is to divide the expense total by the total labor hours. Sometimes the total expense is divided by the total payment for productive labor, which is equal to the total labor hours multiplied by the average labor-hour rate. Where the total hours of productive labor form a factor of the

expense account divisor, the quotient so obtained is an increment which must be applied to each and every hour of productive labor to obtain the total, or selling, cost of the product.

It is obvious that factory product cannot justly be sold to the consumer for anything less than the total cost, obtained by adding the proportionate share of the expense account to the material-and-labor cost, or prime cost. If the product is sold for less than total cost as thus determined, the seller is guilty of an economic crime which carries with it an immediate penalty in the form of a money loss to the seller, and a long train of contingent and following consequences of the most unfavorable description.

Experienced manufacturers are well aware of the extent of "demoralization" of trade in a certain line over the whole continent, by the eager efforts of one firm to enter new territory by selling at a lower price than can be maintained. If the firm seeking new business offers thoroughly good work with its low price, the damage worked becomes incalculable; indeed, it is not improbable that, under such conditions, a return to former prices may never be effected, although the manufacturer who was guilty of selling the good commodity at less than a fair price speedily forces himself out of the business. If, however, the new man who couples good work with a price reduction is able to continue in business and maintain the quality of his production at the reduced price, he has done no economic wrong, but has become an industrial benefactor.

A correct business transaction is not an exchange of values in which one side gains while the other side loses or merely obtains a new dollar for an old one; it is a transaction which both parties would be glad to repeat indefinitely, both having obtained fair equivalents. From this point of view, the manufacturer who sells at a price below his total cost makes a gift to the purchaser at an expense to himself exactly equal to the value of that gift, for which he will never obtain any equivalent. If this were all, the transaction would concern only the immediate principals. But it is not all; the producer who has a good plant, well managed, and sells his product below a fair price, including his own earning power, has taken a long step towards reducing the value of that product generally and placing a prosperous business on an insecure footing. Nothing could be more reprehensible from an economic standpoint.

And these assertions are beyond dispute. They are logical deductions from accurate cost-ascertaining, and are infallible.

Let us see exactly what cost keeping can tell the cost keeper and manufacturer. Suppose that the factory accounts are made up completely once in three months. The general manager then knows ex-

actly what his product cost him in each 90 day period. This does not say that he knows exactly what the cost of this product will be for the three months to come. The future costs, if made with the same number of men in work and under the same general conditions, should be very close to the costs of the last three months.

But the business volume of many factories is dependent, to a great degree, on the season of the year, and in this case there may be a great difference in the number of men in work in succeeding quarters; the expense apportionment per hour of labor, or per average hour cost of labor, may be, and in some manufactures regularly is, only half as great in one period of three months as in that which preceded it. Clearly, in this case, the three months is too short a time period, and the whole year's transactions must be considered in establishing the averages by which the selling cost is fixed.

If this is done, a fair price for last year's production is known; but how about this year? An accurate record of past performance is of but little value, if it does not afford a guide for improvements in future action.

And here comes in the sympathetic factor. The factory can wait; its assets are not extinguished by the flight of short periods of time. Not so with the workman, whose power of earning comes, and goes away forever, with each tick of the clock. Must the workman be laid off and lose his time, because the manager is unable to find customers who will pay the average total cost of his production of the past year? The intelligent manager well knows the results of broken employment; it greatly injures the workman, who is most unlikely to use his idle time to any sort of benefit to himself; it entails high labor cost of the factory product, because of the high wages which must be paid where employment is irregular, and because, in every department of every factory, there is a strong inclination to keep valued workmen on, though there is really no work for them at the moment.

Suppose that the manager says to himself: "My expense account was $2,000 for the month of last year corresponding to this, and the expense conditions are about the same now as then. I have an inquiry which I can transform into an order by fixing a price covering flat costs and 50 per cent. of the expense which they should carry. Shall I place a figure on my tender which will bring the work to me, or shall I place my price where it really belongs, with the certainty of seeing the work go somewhere else?"

This is a problem to be resolved by subtle minds.

Suppose the manager settles it by the sole consideration of keeping his good men, his willing and valued servants, fully employed. That is the exercise of the factor of sympathy, at the cost of an econ-

omic crime on the part of the manager. The low price is named, the tender is accepted, and the factory goes merrily on, full handed.

Suppose now, in continuation of this incident, that other inquiries are received and replied to with low tenders, which are accepted, so that, by increased number of men in work, the expense due to the period of time is fully met. The manager has then absolved himself of his original economic sin, although he has possibly lowered the price of his product permanently. But what if he has thereby increased his sales, or the probability of sales, sufficiently to leave him better than he was?

A well-known law of sales declares that price reductions increase demand permanently, and it is not impossible that this sympathetic manager finds himself nothing out of pocket by his consideration for his men.

On the other hand, suppose the manager to be perfectly informed and a rigid economist, a man of purpose and determination, whose axe hews to the line, let the chips fall where they may. In this case, he makes, in answer to the first inquiry, a tender which does not obtain the order. His workmen are laid off. The following inquiry must perforce receive a similarly uncompromising tender, with the same result of loss of the order. Perhaps, in the case of a subsequent inquiry, the necessities of his workmen, now long enough out of work to have become paupers, may induce him to make tenders which secure an order, on which he can make nothing at all above flat cost, for the reason that he has nothing else to speak of in the course of production in the factory.

Of these two managers, who differ from each other only perhaps in the melting point of their sympathies for their workmen, there are many actual examples.

In the case of standard products, replies to inquiries for estimate often differ by a surprisingly small margin when coming from long-established firms of high repute. Between two such firms a very few dollars often determines the placing of an order, and the gaining of two or three successive orders may place the factory on a sound basis of profit for a considerable period of time, where either order alone would have been unsatisfactory.

Hence the extreme importance of knowing the very last dollar which, in view of all the present conditions of the factory, can be prudently deducted from the gross total of a tender. Such knowledge can be had only by detailed cost keeping. Minuteness of detail is by no means an index to the clerical labor involved in carrying out a cost-keeping system, while nothing short of minute detail can give the power of making close estimates.

THE MINING, SMELTING, AND REFINING OF NICKEL.

By Titus Ulke.

THE entire nickel-ore supply of the world, amounting to more than 100,000 tons annually, is obtained, with the exception of a few hundred tons, from just two localities—the Sudbury district of Canada and the French island colony of New Caledonia. There is a radical difference in the character of the ore mined in these two countries, the Canadian ore containing both sulphur and copper, while the Caledonian ore is free from both ; their metallurgical treatment is therefore correspondingly varied.

With Canadian ore the raw material must first be roasted ; it is then smelted to a matte, which is sometimes concentrated by bessemerizing, but is more generally treated directly by the Orford method, so as to separate its copper from its nickel, the final traces of copper being removed from the crude nickel by an electrolytic process.

In treating New Caledonian ore the ore-roasting is avoided, but sulphur, in some suitable compound, such as gypsum, must be added to form a matte during smelting, which operation is generally followed by roasting and refining in reverberatory furnaces.

I shall now endeavor to describe the general methods of mining and smelting used in each case, giving the items of production and cost and many other data of importance. Only the present practice in the metallurgy of nickel will be considered, the subject-matter being divided under the following sub-heads :

1. Nickel mining in Canada.
2. Nickel mining in New Caledonia.
3. The roasting of the Canadian ore.
4. The smelting for matte.
5. The bessemerizing of matte.
6. The Orford process, or separation-smelting.
7. Reverberatory refining (English method).
8. The wet process of refining.
9. Electrolytic refining.

The Mond process, by which six tons of nickel were produced per month, during a part of last year, at Birmingham, England, has not yet been proved a practical success, and therefore need not be described here.

1. Nickel mining in Canada.* As far back as 1856 the existence of copper and nickel in the dingy-green magnetic trap southwest of Sudbury, Canada, was already known, but the inaccessible nature of the country at that time deterred prospectors from making a very detailed examination and from staking out claims. So it was not until 1883 and 1884, when the Canadian Pacific Railway was in course of construction, that the first discoveries of any importance were made. An accident, not infrequent in newly-settled districts, led to the first important discovery. Judge McNaughton, a magistrate of Sudbury, had been lost in the woods to the west of the village, and a diligent search was at once instituted for him. One of the searching parties found the judge seated on the small eminence which marked the site of what is now known as the Murray mine. Early in 1884 the Canadian Pacific made a cutting for their main line through this small hill, about three and a half miles west of Sudbury. Dr. Selwyn carefully examined the location, and pronounced the lode exposed to be the most promising he had yet seen in Canada. Other discoveries soon followed, and the McConnell, Lady Macdonald, Stobie, Blezard, Copper Cliff, Evans, and Vermillion mines were all located. At first the wildest notions were entertained as to the extent, and the most exaggerated reports circulated as to the value, of these deposits.

Rounded hills, or ledges, of reddish brown gossan, varying from a foot to many feet in thickness and indicating the presence of the more solid and unaltered ore beneath, occur at intervals for miles in a southwesterly direction, and thus rudely conform to the strike of the rocks in the vicinity.

The nickel ore occurs in lenticular masses, chutes, and pockets, and not in veins, though in some cases these masses are connected by elongated deposits which have somewhat the appearance of veins. Faults and dislocations are met with frequently.

The Huronian system, in which the ore deposits are found, may be regarded as the oldest series of sedimentary rocks of which we have any certain knowledge. The origin of the nickel and copper is, undoubtedly, closely connected with the trap rock, which has broken through the Huronian strata, and the formation of the fissures containing these ores was, no doubt, due to the disruptive forces of the intrusion and the contraction caused by the subsequent cooling of the igneous rock matter. These fissures were, necessarily, most frequently formed along the line of contact with the cooler sedimentary strata, although, in certain cases, they were formed in the midst of the igneous mass itself. In nearly every instance, therefore, the de-

* The writer has freely used the articles by D. H. Browne, R. H. Ahn, D. Levat, F. Benoit, and other authorities on nickel, and especially begs to thank Mr. H. P. McIntosh, secretary of the Canadian Copper Company, for his critical revision of this manuscript.

posits of nickel and copper occur close to the contact of the trap with the stratified rock, and they are rarely found in the trap near its junction with granite.

Mining is rendered somewhat difficult and uncertain at Sudbury by the absence of regular walls to the deposits and by the irregularity of the distribution of the ore, which often impregnates the enclosing rock so that there is no means of knowing exactly in what direction to drive the levels. This uncertainty, however, is more than compensated by the extent and massiveness of the deposit when found. That these deposits extend to some considerable depth is proven by the workings at the Copper Cliff, where a shaft has been sunk on a 40° slope to a depth of nearly 900 feet, at which very high-grade nickel ore is being mined.

In 1886 the Canadian Copper Company, incorporated with a subscribed capital of $2,000,000 (afterwards increased to $2,500,000) was formed to operate the Copper Cliff, Stobie, Evans, and other mines. The three mines mentioned were opened up in the latter part of the year, and, excepting an occasional stoppage during the winter months, they have been in active operation ever since. It is generally stated that the Canadian mines began to yield in 1889, when nickel matte was first shipped to the United States for refining.

The ore of the principal Sudbury mines consists of a black trap rock, usually containing impregnations or brecciated masses of nickeliferous iron sulphide (pyrrhotite) and copper iron sulphide (chalcopyrite). The chief nickel-bearing mineral is the pyrrhotite, in which nickel replaces iron in irregular proportions.

It is interesting to note that, as the mines deepened, at least up to the seventh level, the ore changed in character from a distinctively copper ore at the surface to a distinctively nickel ore in depth. The Copper Cliff mine, for example, produced, on the first level, a chalcopyrite, in which the nickel was found by accident after large shipments had been made of the ore as a copper ore alone. On the fourth and fifth levels the ore averaged about 4 per cent. copper and 4.5 per cent. nickel, while on the seventh level many stopes showed an average of only 0.5 per cent. copper to 8 per cent. and even 10 per cent. nickel. However, the levels below the seventh have brought forth ore with a larger percentage of copper than of nickel.

From the mines the ore and barren-rock are hoisted to rock-houses, where the material is roughly hand sorted, the gangue-rock or waste being discarded. The ore, much of which is still attached to barren rock, is now crushed by Blake crushers set to a 4 inch space between jaws, and then delivered to revolving screens, the ragging or medium ore passing a 1¾-inch and the fine ore a ¾-inch opening.

COPPER CLIFF MINE YARD.

The raggings and fine ore slide directly into their respective bins, while the coarse material, not passing through the screens, falls from the latter upon washing tables. It is here passed under a spray of water, and, while being carried onward by the jerking motion of the tables, is rapidly sorted by boys, who pick out any pieces which contain nickel or copper and throw these into bins, while the waste rock falls from the ends of the tables into a larger hopper, from which it is loaded into cars.

The following analysis represents the composition of an average month's output of ore from the Copper Cliff, Evans, and Stobie mines: nickel, 2.5 per cent. to 5.5 per cent.; copper, 1.5 per cent. to 4.5 per cent.; silica, 12 per cent. to 24 per cent.; iron, 35 per cent. to 45 per cent.; sulphur, 18 per cent. to 26 per cent.; alumina, 3 per cent. to 8 per cent.; lime, 2 per cent.; magnesia, 1 per cent. to 1.5 per cent.; besides oxygen, traces of phosphorus, manganese, and moisture. The fines show a higher average metallic value than does the ragging or coarse stuff. The material is now ready to be shipped to the smelting works, to be roasted and smelted into matte. The average cost of mining one ton of ore in Sudbury is said to be about $5.

2. Nickel mining in New Caledonia. The nickel belt of New Caledonia extends for many miles, principally along the east coast of this remarkable island. Some of the richest nickel mines in the world have been developed there, the average ore extracted being higher in

grade than the average Canadian ore. The New Caledonian nickel-bearing mineral—a brilliant green hydrated silicate of magnesia and nickel, called Garnierite—was discovered in 1867, but its occurrence in sufficient amount to be of commercial value was not ascertained until 1874. It is found in fissures in serpentine, and often occupies basins and cavities in this rock at, or near to, its contact with red clay. Evidently the mineral was deposited by percolating waters in the veins or concretionary masses in which it occurs.

The lodes containing the nickel ore vary much in size, the maximum width being about twenty-five feet; but in some cases the whole of the rock is filled with small veins of the mineral, so that it may be worked as a whole up to a width of nearly two hundred and fifty feet. Only the larger veins in the hard rock are worked by underground mining, as this is rendered difficult by the irregularity of the vein walls, which are easily lost. By far the greater number of the mines are worked therefore as open cuts.

In vein mining inclines are sunk on the lodes and are connected by levels, the ore being stoped from below toward the surface and the waste dropped behind. A queer spectacle is presented by the Caucasians, Mongolians, Malays, and Papuans working side by side in

HOISTING WORKS AND ROCK HOUSE, COPPER CLIFF.

the mines and open cuts. The actual mining is performed by a few Englishmen, who are paid from $1.20 to $1.80 per day, Kanakas, who are given their board and four dollars per month, and Annamite and Tonkese prisoners, galley slaves, and convicts obtained by contract from the French government. The best workmen are said to be the freed convicts, who earn from $1 to $1.20 per day.

The cost of mining the New Caledonian ore varies from $3 to $8 per ton, according to the position and condition of the mines, some of which are situated high up in the mountains, while the cost of transporting the ore from the mine to the port of shipment ranges from 10 cents to $2 per ton. Ore containing from 7.5 per cent. to 8.5 per cent. nickel delivered at shipping port was valued at $21, and ore with 9.5 per cent. to 10.5 per cent. nickel at $25 per ton in 1890. The freight from Nouméa to Havre, France, is about $8 per ton of ore, having been $10 before the company "Le Nickel" had its own ships.

There are two companies operating in New Caledonia, "Le Nickel" and the "Société d'Exploitation des Mines de Nickel," the latter working a few mines belonging to the former. Besides these there are several smaller mining enterprises. Le Nickel has smelting works at Havre, and buys nearly all the ore mined in New Caledonia. This company has acquired large tracts of mineral land on the island, but is working only about a thousand hectares, from which, however, it is claimed, it earned a net profit of more than $1,200,000 in 1891, with a capital stock of only $2,500,000.

The principal mining districts are Thio, Nakety, Canala, and Kouaoua on the east coast, and Dumbea, Paouea, and Koniambo on the west coast. All the mines of Le Nickel lie in the Thio district. In 1890–91 the company extracted fully 33,000 tons of ore averaging 10 per cent. nickel, and in 1892 and in 1893 respectively, it exported ore containing the equivalent of about 600 and 1,000 tons of nickel.

It is understood that little has been done at the mines since the great storm in the spring of 1894, which destroyed a number of the company's buildings and other works, and that the company has limited itself during most of the time since to working up its accumulated stocks of ore in Europe and in New Caledonia. The company has undoubtedly felt severely the sharp competition of the Canadian metal, which could be put on the market at lower prices than its own product.

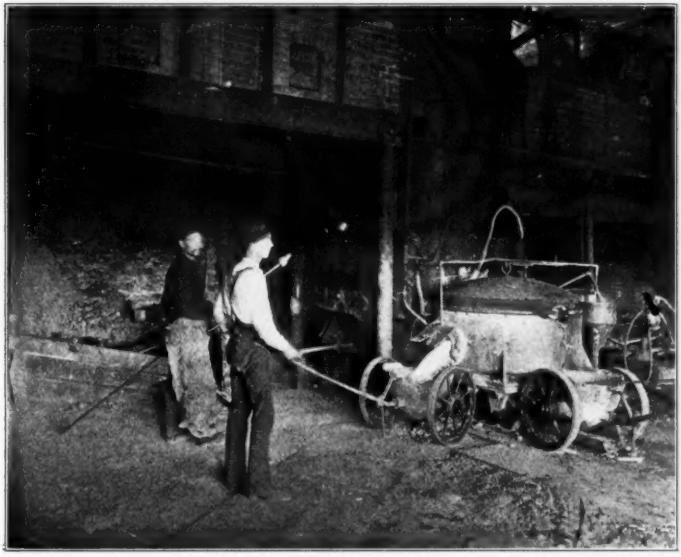
3. The roasting of the Canadian ore. In the roast yard of the smelter at the Copper Cliff, space is provided for roasting about a quarter of a million tons of ore per year. The Canadian Copper Com-

ROAST HEAPS AT THE COPPER CLIFF MINE.

BUILDING A ROAST HEAP.

pany has usually about 50,000 or 60,000 tons of roasted ore on hand ahead of the smelter. For roasting the raw ore, the ground is first leveled off, a few inches of fine ore distributed as evenly as possible over the soil, and then sticks of cord wood are placed, side by side, across both sides and ends of the rectangular area, to a height of about 18 inches. The whole interior of this can be filled in with stumps, roots, ties, or cord wood, but in such a way as to form a level and solid bed for the ore to rest upon. Over all this is placed small wood and chips to fill up all interstices, care being taken to provide small canals, filled with kindlings, at intervals of eight or ten feet, leading from the outer air to the chimneys along the center of the heap. When the bed is so far arranged, the coarse ore is piled to a height of five or six feet and covered with a layer of raggings, on top of which is sometimes scattered a layer of rotten wood or chips, and then the whole heap is topped and banked at the sides with six or eight inches of fines. Each roast heap holds from 600 to 1,800 tons of ore. Only a portion of the fine ore is put on at first, the rest being shoveled on after the fire has been fairly started. About twelve hours after the firing of the heap dense fumes of sulphurous acid will be discharged. Great attention is at first paid to the pile to avoid undue local heating, which would cause partial fusion of the ore. This is prevented by the addition of more fines to the part showing too much heat. Each roast heap burns from six to ten weeks, and during the operation the sulphur is lowered from an average of 22 per cent. to about 7 per cent., the iron is in large part oxidized, and the trap rock or

BURNING ROAST HEAPS AT SUDBURY.



INTERIOR OF NICKEL-SMELTER BUILDING. THE END OF THE MATTE FLOW.

diorite is thoroughly disintegrated by the swelling and oxidation of the ore. After the ore is thoroughly roasted, it is cooled and conveyed for further treatment to the blast furnaces in the smelter. The cost of heap roasting at Sudbury is said to be forty cents per ton.

4. The smelting for matte. At the Canadian Copper Company's works at Sudbury the furnaces are of the Herreshoff pattern, of boiler iron, water jacketed, about 9 feet in height to charging door, of oval section 6 feet 6 inches by 3 feet 3 inches, with 2 inch water space, and provided with an exterior, brick-lined, water-cooled forehearth or well. The capacity of each furnace is about 125 tons of ore, or 15 tons of matte, in 24 hours; three furnaces are always in operation.

The charge consists of the ore and coke, together with nickeliferous slag from the matte-smelting furnaces or bessemer converters, when these are in operation. By arranging so that the matte and slag flow out of the furnace into the forehearth as rapidly as formed they escape the influence of the blast, and thus prevent the causing of "sows" or "salamanders," as the great masses of metallic iron, which may choke up the furnace and tie up large quantities of copper and other metal, are called. The matte is tapped from the well into cast-iron conical matte pots, in which it is allowed to cool. The slag runs con-

NICKEL-SMELTER BUILDING AT SUDBURY, SHOWING SLAG ELEVATOR AND SPILLED MATTE.

tinuously over a slag lip at the top of the well, and is allowed to flow through an opening in the floor, where a powerful jet of water granulates it and carries it to the dump.

The process of smelting is very economical, the ore furnishing in itself the exact ingredients necessary for fluxing, so that, by skilful mixture of the ores, the company has avoided the necessity of putting a pound of extraneous flux into its furnaces. About 15 per cent. of Connellsville coke is used to reduce the ore to matte, or, in other words, one pound of coke makes nine-tenths of a pound of cupola matte. Thus about six tons of ore are concentrated by smelting into one ton of matte. The average grade of matte will analyse as follows: copper 20 per cent. to 25 per cent.; nickel, 18 per cent. to 23 per cent.; iron, 25 per cent. to 35 per cent.; sulphur, 20 per cent. to 30 per cent. One ton of ore is said to cost between $6 and $7 to mine, roast, and smelt, the nickel in the matte, when bought in quantities of at least 400 tons monthly, selling for about 8.75 cents per pound and the copper at 3.40 cents per pound. It is stated that the Canadian Copper Company is now under contract to deliver all

COKE SHED, SMELTER BUILDING, AND MATTE DUMP, COPPER CLIFF MINE.

BESSEMER FURNACE BUILDING AT SUDBURY.

its matte to the Orford Copper Company, so that no Canadian matte is at present on the market.

It is stated that in the treatment of New Caledonian ores at Glasgow, Havre, and Iserlohn, the ore, together with gypsum, alkali waste, or saltcake, is charged (with the necessary amount of fuel) into low, water-jacketed blast furnaces. In the smelting process the silica unites with the magnesium and part of the iron of the ore and the calcium or sodium of the gypsum or salt-cake to form a slag, while the nickel and part of the iron of the ore unite with the sulphur of the gypsum or saltcake to form a matte. The products, therefore, are a slightly-nickeliferous slag, which goes to waste, and a highly-nickeliferous matte, which must be refined. The refining operations will be described later under the heads of Bessemerizing and Reverberatory-Refining.

THE LATEST IMPROVEMENTS IN THE FRENCH LIGHTHOUSE SYSTEM.

By Jacques Boyer.

THE powerful lights along the French coast, which were described in the preceding paper, represent advances in mechanical and optical devices which find their culmination in the new Eckmühl lighthouse—a veritable masterpiece, containing the latest improvements. The name Eckmühl is given in memory of Marshal Davoust, prince of Eckmühl, because his daughter, Mme. la marquise de Blocqueville, who died in Paris on October 7, 1892, left in her will one-half the money necessary for its construction, upon the condition that it should be so named. The structure was completed and formally inaugurated on October 17, 1897.

The general arrangement of the new light consists of a bi-focal system constructed by MM. Sautter and Harlé, of Paris. It is composed of two sets, each containing four annular lens systems (Fig. 12). In other words, the dioptric and catadioptric portions have distinct foci, situated on the axis common to the carbons and the apparatus, and placed in the horizontal planes corresponding to the points of maximum incandescence of the carbons. The lower carbon is placed in the focus of the dioptric elements, this forming the

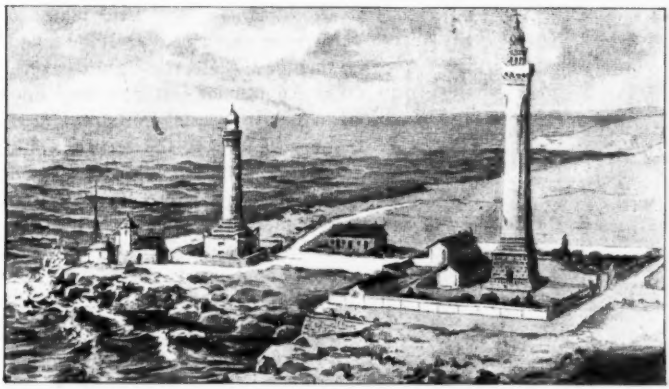


FIG. 10. PERSPECTIVE VIEW OF THE ECKMÜHL LIGHTHOUSE AND ITS SURROUNDINGS.
The bequest of the marquise de Blocqueville was 300,000 francs, and the Eckmühl lighthouse cost more than 600,000 francs.

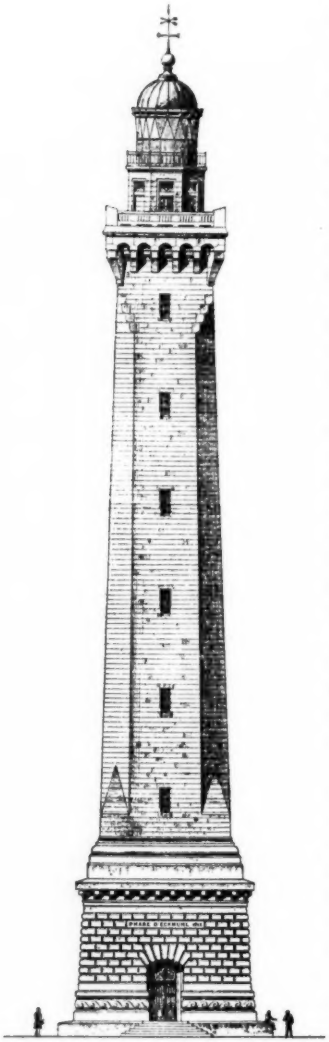


FIG. 11. ELEVATION OF THE ECKMÜHL LIGHTHOUSE.

Situated on the Point of Penmarch; inaugurated on October 17, 1897.

lower focus. It therefore sends its most powerful rays over the horizon. The upper carbon is placed in a corresponding relation to the focus of the elements of total reflection, forming the upper focus. This distribution is the most advantageous, because at the horizon, where the maximum intensity is most useful, the effects of the two sets of rays are superimposed. It has even been shown experimentally that the amplitude of the combination of rays extends beyond the limits of the horizon.

The optical apparatus is carried upon a cast-iron base plate supported by a vertical shaft of wrought iron. This spindle is guided at its upper part by a bronze collar and held by a sleeve below, the end forming a pivot resting in a socket. The sleeve may be adjusted vertically by a screw in such a manner as to enable the socket to be regulated, making possible also the adjustment of the base plate to a crane serving to introduce and change the electric-light carbons.

An annular cast-iron float, immersed in a vessel containing mercury, is fixed to the vertical shaft, and, by means of adjusting screws, this float may be exactly centred in the mercury vessel. Each of the two conductors carrying the current connects with an annular trough filled with mercury and supported by an insulating material. This enables a complete electrical connection to be maintained through the mercury, notwithstanding the rotary motion. The axis of

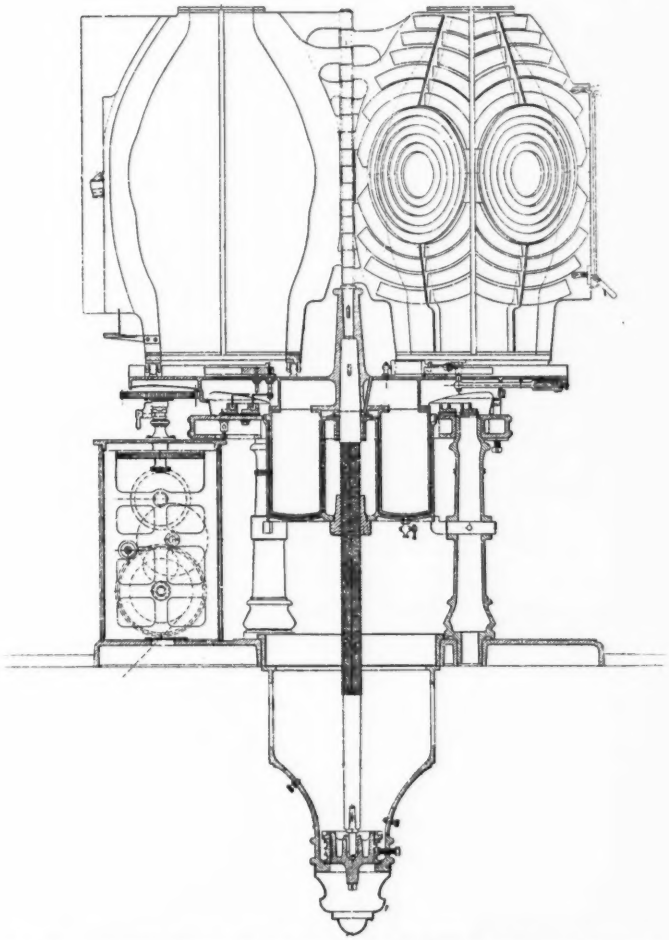


FIG. 12. VERTICAL SECTION OF THE OPTICAL APPARATUS OF THE ECKMÜHL LIGHT-HOUSE, TAKEN THROUGH THE AXIS OF ROTATION.

the mercury troughs coincides with that of the shaft, and the troughs are supported by the cast-iron bearing which holds the upper part of the shaft. This support is placed upon the metallic base plate of the lantern, and by its side stands the rotating mechanism. The buoy-

ancy of the mercury supports the weight of the moving parts, and so reduces the resistance that a complete revolution can be effected in twenty seconds by means of a comparatively small driving weight. Only one hundred and five kilogrammes of mercury are required in the float vessel, and the apparatus operates with perfect smoothness and regularity. With the old system of ball bearings, the dust from the electric-light carbons caused rapid wear, and it would have been impossible to attain the high rotative speeds required for the lightning-flash system. The two systems of lenticular panels, symmetrically placed, and having their optical axes parallel, give the same effect when rotated as if they formed but one system. The advantage of this arrangement is very marked, since it has been ascertained experimentally that, if the intensity of the voltaic arc is increased, the illuminating power is not increased proportionally. For this reason it is preferable to use two arcs. Thus with 25 amperes and 45 volts, by means of a single flash-light system, a light of 1,200,000 carcels is obtained, while with 50 amperes and the same voltage an identical

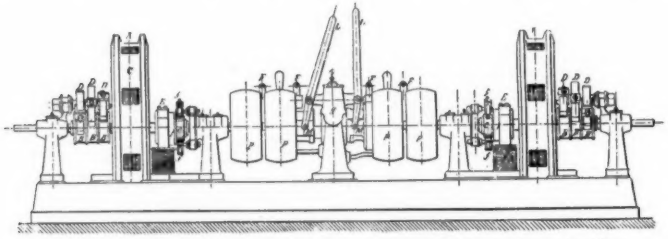


FIG. 13. CLUTCH MECHANISM OF THE ALTERNATORS AT THE ECKMÜHL LIGHTHOUSE.

system gives only 1,800,000 carcels, instead of 2,400,000. The advantage of doubling is thus clearly seen. With 50 amperes in each arc, a luminous intensity of 1,800,000 carcels, or a total of 3,600,000, is obtained, while with 100 amperes and a single arc, only about 2,300,000 carcels would be attained. These figures must be somewhat reduced in practice. The new lighthouse, which is operated in two different ways, according to the state of the atmosphere (as will be seen hereafter), has an illuminating power somewhat less. When the two arcs receive each 25 amperes, it furnishes a light of at least 1,500,000 carcels, and, when they use 50 amperes, they possess the enormous intensity of 3,000,000 carcels.

Its luminous range in medium weather is then 90 kilometres, or about 49 sea miles. In hazy weather, which prevails about one day in ten, it may be seen for 19 miles.

The motive power is furnished by two strongly-built steam engines of 12 h. p., provided with an aero-condenser devised by M. Monin, which returns 75 per cent. of the water evaporated,—a matter of importance in this instance, since the lighthouse is placed where it is difficult to procure fresh water.

The two electric generators are of more interest than the engines. They have been constructed from the designs of M. Blondel, engineer of the *Ponts et Chaussées*, by the "*Société de l'Eclairage Electrique*," and are biphase alternating dynamos of the Labour type. These are well adapted for the varying service; moreover, the alternating current is more economical than the continuous current. They are driven

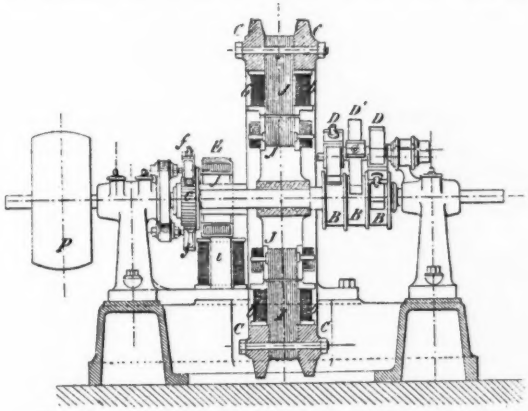


FIG. 14. LONGITUDINAL SECTION OF ALTERNATOR AT THE ECKMÜHL LIGHTHOUSE.

by separate belts, at a speed of eight hundred revolutions per minute, and each generator (Fig. 13) consists of three parts: (1) the exciter E, a small continuous-current generator, composed of a field electro-magnet i, a Gramme armature j, attached to the shaft, and provided with a commutator c, and a pair of brushes ff, to collect the current generated during the revolutions; (2) the fixed inductors, or field electro-magnets, II, with cores composed of thin plates of sheet-iron clamped together by a bolted cast-iron ring, upon which the bobbins of insulated copper wire are wound (Fig. 14), these inductors having eight poles, alternately north and south, and the eight bobbins forming a single circuit supplied by the current from the exciting dynamo; (3) an armature, composed of plates of sheet iron J J (Fig. 15), attached to the shaft, and notched to receive sixteen bobbins of insulated copper wire. These bobbins compose two superimposed cir

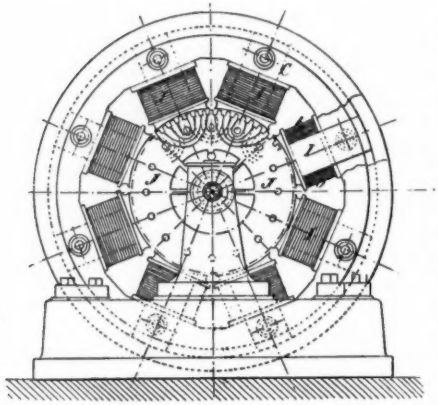


FIG. 15. ELEVATION OF ALTERNATOR AT ECKMÜHL LIGHTHOUSE.

cuits overlapping each other for half the width of the bobbin, in such a manner as to produce a biphase alternating current. The first circuit is composed of eight bobbins, the wire of which is indicated by a full line in the illustration; the second circuit consists of the remaining eight bobbins, shown in dotted lines. The rings B, B′, B″ collect the currents generated in the circuits during the revolution of the armature. Each of the first two rings belongs to one circuit, and the ring B′ is common to both. The brushes D, D′, D, which bear upon these rings, are connected to the ports on the base of the machine, and thence to conductors.

The switchboard (Fig. 16) consists of a panel upon which the conductors and controlling devices are fixed. The ports 1 to 12 of the switchboard are connected with the ports of the generators by means of insulated conductors, and the opening and closing of the circuits are effected by the switches JJ′, KK′. Finally, to maintain the same polarity in the two exciters, and in the poles of the alternators, provision is made for coupling and uncoupling them.

The measuring apparatus consists of two lamps, a voltmeter, and an amperemeter; besides which there are several regulating devices. Among these are two rheostats RR (Fig. 16). Each of these belongs to a separate generator, and is used to regulate the current passing from the exciter to the fields. There are also four transformers JJ, KK, by which the currents are reduced to the working pressure (45 volts—25 amperes), as the intensity would otherwise be too high.

The clutch mechanism G (Fig. 13) enables the belt for each alternator to be shifted from the fixed to the loose pulley, or to unite the two fixed pulleys when it is desired to couple the alternators; for, as has been said, the lighthouse may be operated in two different ways, according to the condition of the atmosphere. This apparatus is composed: (1) of a short shaft, upon which are mounted two loose pulleys P′P′, fitted with clutch rods which may be engaged with cor-

responding holes in the fixed pulleys PP; (2) of two sleeves MM, carrying clutch jaws, which may be engaged by aid of the two levers LL; (3) of the two shifter forks F, by means of which the belts may be shifted from the fixed to the loose pulleys; (4) of a lubricating cup, forming a portion of the bearing.

The regulators for the electric arcs are of the Serrin type, with slight modifications, and enable either of the two systems of lighting to be used merely by changing the carbons. In order to facilitate the control of the light by the attendant, a small prism and lens are attached to the optical apparatus, which projects the image of the carbons upon a screen of ivory. On this screen is a reference line marking the position at which the most incandescent point of the lower carbon should be constantly seen. When the attendant sees that this point is displaced, he raises or lowers the arc by means of a regulating screw acting upon both carbons. A similar lateral adjustment is provided.

In foggy weather a sound signal is used. This consists of a siren placed in the upper gallery and operated by air compressed to two atmospheres. A supply of air compressed to fifteen atmospheres is always maintained in a storage tank, so that the signal may be started at a moment's notice, a reducing valve enabling the working pressure of two atmospheres only to reach the siren. The siren is adjusted to the note mi_3 (326 vibrations per second), as it has been found that a deep note penetrates the fog to a greater distance than one of higher pitch.

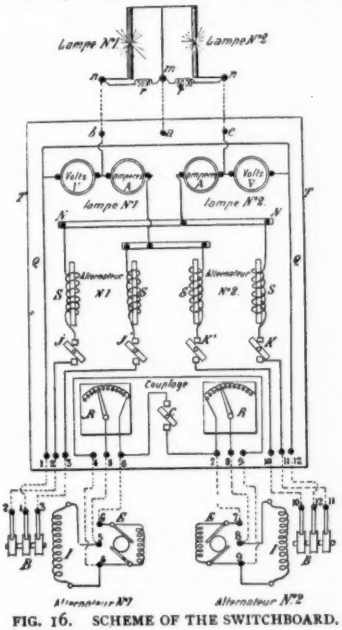


FIG. 16. SCHEME OF THE SWITCHBOARD.

The architectural features of the structure (Fig. 10) have received as much attention as the rest of the work. The old lighthouse has been retained as an annex. The new structure, designed by the architect, M. Marbeau, consists of an octagonal tower of granite (Fig. 11). The focal plane of the lamps is 59 metres above the ground and 60 above high water, and its outline may be seen in clear daylight thirty kilometers out to sea.

This lighthouse surpasses all others in the world, not only in the range of its light, but also in its equipment. As a matter of comparison we may note that the most powerful English lighthouse is that of St. Catherine, on the Isle of Wight, which has a luminous intensity of 600,000 carcels. The completion of this great structure has been greatly to the honor of M. Bourdelles, director of the lighthouse service, M. Ribiére, chief engineer of the same service, and MM. Blondel and de Joly, the assistant engineers, by whom it was constructed.

It some cases it is desirable to use a lighting system which shall operate for extended periods without the care of a keeper; the conditions of such a system have been successfully met in connection with the lightning-flash system. The first of this kind to be erected in France was at Belle-Isle, in 1890, since which time several others have been put into operation. The most remarkable and the latest device of this kind of light is that of MM. Barbier and Bénard, in which the rotation is effected by means of an electric motor. It is used with excellent results in the lighthouse of Ville-ès-Martin, at the mouth of the Loire, near St. Nazaire. This "permanent" lightning-flash is of the sixth order (0.150 metre focal distance), with two white group flashes, of a duration of one-tenth of a second. The interval in a group of two flashes is two seconds, and that which separates two groups is eight seconds. Fig. 19 shows the case opened, in order that the internal arrangement may be seen. Devices of this sort are being constructed for the lighthouses at the Point de Nalde (Pas de-Calais) and at Isle-de-Bréhat (Côte-du-Nord). Lights of this sort are especially adapted for use on jetties and other positions inaccessible in bad weather, but not of sufficient importance to demand the constant presence of an attendant. With all the precautions which can be taken, however, they render an imperfect protection, but, as they cause a marked reduction in operating expense, they will doubtless continue to be used, not only in France, but elsewhere.

Lightning-flash lights are now being successfully constructed with the Auer, or Welsbach, incandescent gas burner. The first application of this sort was made in 1895 at the Chassiron lighthouse, on the Isle d'Olèron, and the results were so satisfactory to the lighthouse administration that it was decided to apply this system to all lights of the first order hitherto using oil lamps. In 1896 the lighthouses of the Isle de Groix (Morbihan) and of the Isle de Sein (Finistère) were supplied with these lights. The apparatus of the Ar-Men lighthouse (Finistère) has been placed in the hands of the Société des Etablissements Lepaute, to be converted into an incandescent gas system, and is expected to be in full operation by the close of 1898. This, the

latest, type of lighting apparatus (Figs. 17 and 18) consists of three panels with catadioptric above and below, and central dioptric elements, presenting a horizontal opening of 72°. A portion of the light which is emitted in the "dead" angle is utilized by a spherical reflector of pure nickel, of 144° amplitude. The apparatus is so arranged that it may be used either with mineral oil, or with compressed gas burned in incandescent burners. The oil lamp has six wicks, and is provided, like the gas burner, with a mercurial joint, which permits an instantaneous substitution of one burner for the other. The connection to the gas burners consists of a tube formed of the spindle itself, a hole being formed in its centre for a length of 170 metres, terminating in an annular tube filled with mercury. The whole is supported upon a cast-iron plate, to which is attached a vertical shaft provided with a screw-thread at the lower end. This shaft is held above by a bearing attached to the cup, and below by an adjustable socket supported on a cast iron boss carried on the foundation plate. This arrangement has already been employed in the great lighthouse at Fire Island, in the United States.

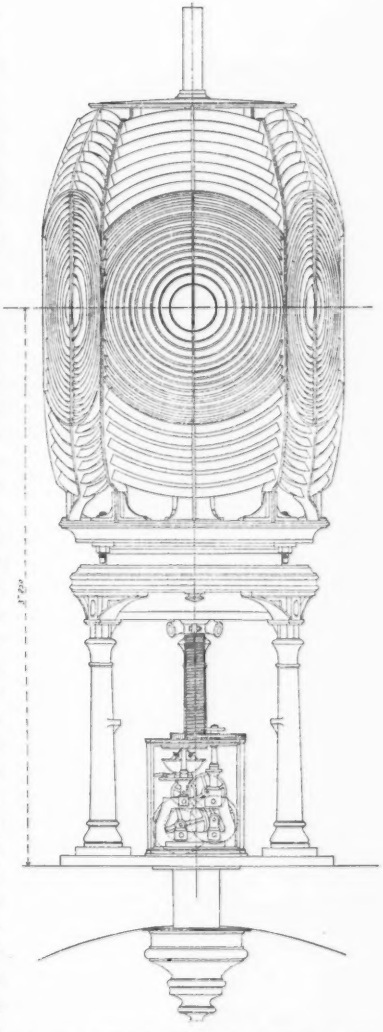


FIG. 17. OPTICAL APPARATUS OF THE AR-MEN LIGHTHOUSE.

It has the advantage of enabling the vertical shaft to be prolonged, thus insuring a greater degree of stability and reducing the lateral press-

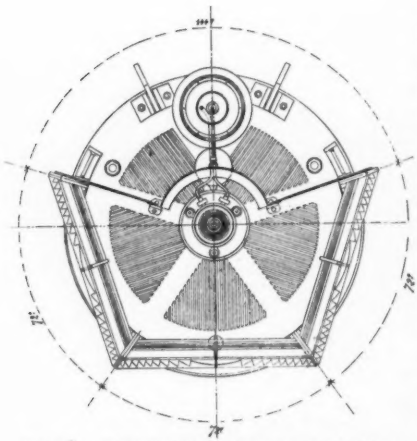


FIG. 18. HORIZONTAL SECTION OF THE AR-MEN APPARATUS.

ure upon the upper bearing. The mercurial float is placed immediately below the working plate, and supports the total weight of the moving parts. Rotation is effected every twenty seconds, producing a group of three flashes followed by a long eclipse. The range of this light in clear weather is sixty miles.*

Some lightships serve to assist in landings (harbor lights), others to indicate isolated dangers, and still others to mark the location of channels. It is evident that those of the first-class demand the greatest degree of perfection, and that great solidity of hull is necessary in those of the first and second classes. In the harbor of New York electrically-lighted buoys are used in preference to lightships, but in France such buoys have been adopted only for the plateau of Minquiers (Manche). The lighthouse department considers these buoys well adapted to indicate isolated dangers, but sailors object to them because they are apt to be concealed in the trough of the waves.

The principal improvements in lightships have been made in those intended for harbor service. The methodical observations which have been made for many years demonstrate that the duration of the waves is almost constant for any given point on the sea, although very different at different points. This fact enables the problem of stability to be solved much more precisely in the case of a lightship than in that of an ordinary vessel. It is therefore possible to meet the required conditions effectively, as has been done since 1890 with the "Nouveau Dyck" ship, anchored near the lighthouse of Gravelines (Nord), and which is furnished with much larger bilge keels, to prevent rolling, than have hitherto been used. In the case of the "Dyck," as well as in that of the "Ruytlingen," of which the general arrangements are shown in Figs. 20 and 21, the experimental data have caused the metacentric radius to be diminished, while the lati-

* We are indebted to M. Dehesdin, director of the Société des Etablissements Lepaute for permission to describe this apparatus.

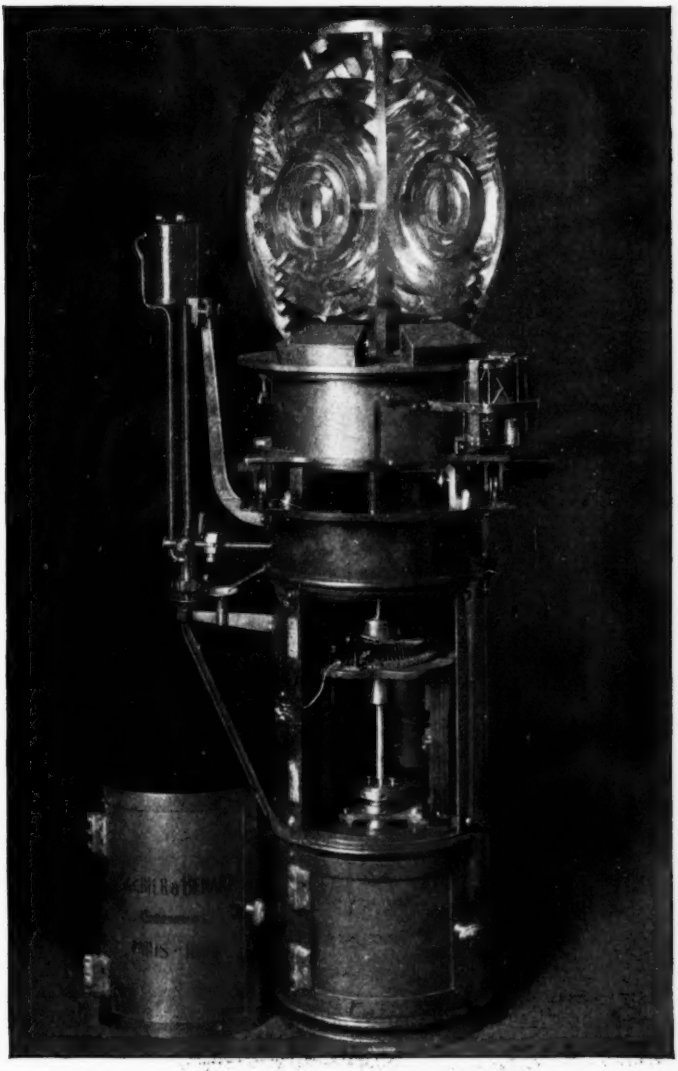


FIG. 19. AUTOMATIC FLASH-LIGHT MECHANISM.
As constructed for the Ville-és-Martin lighthouse.

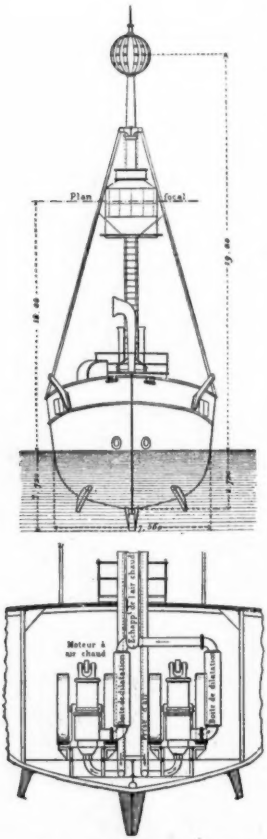


FIG. 20. TRANSVERSE ELEVATION AND SECTION OF THE RUYTLINGEN LIGHTSHIP.

tudinal and longitudinal moments of inertia have been augmented by a new arrangement of the ballast.

The "Ruytlingen," the principal lightship in the French service, has a length of 30 metres, a deck width of 7.82 metres, and a width at the waterline of 7.56 meters, with a displacement of 338 tons. The deck is entirely of steel, and the hull is sheathed with galvanized sheet steel. This vessel was placed in the Dunkerque channel in January, 1891, being held by a mushroom anchor 2,000 kilogrammes in weight, secured by a chain made of iron 40 millimetres in diameter. The iron was required to show, under test, a resistance of 38 kilogrammes per square millimetre of section (54,000 pounds per square inch) with an elongation of 24 per cent.; such strength being deemed sufficient to withstand the heaviest seas.

The lighting apparatus of the "Ruytlingen" (Fig. 20) consists of nine reflectors 0.500 metres in diameter, provided with double-wick lamps, grouped, three by three, in a vertical plane. This gives three sets of luminous rays, each equal to 1,200 carcels. A complete rotation is effected in one minute, the flashes being separated by intervals of twenty seconds. The lamps are maintained at a constant level by means of a Cardan suspension, or universal joint, connected with an internally-toothed ring, into which is geared a pinion carried by a shaft parallel to the mast. The driving machinery rotates the vertical shaft, which imparts the motion to the internal gear wheel and thus revolves the supporting rings in which the lantern is carried. The lantern itself is 2.45 metres in diameter and 3.25 metres in total height, and is attached to the mast by a cylindrical sleeve of sheet-iron. In foggy weather a compressed-air siren produces a group of two tones of the same pitch, alternating with one tone of a different

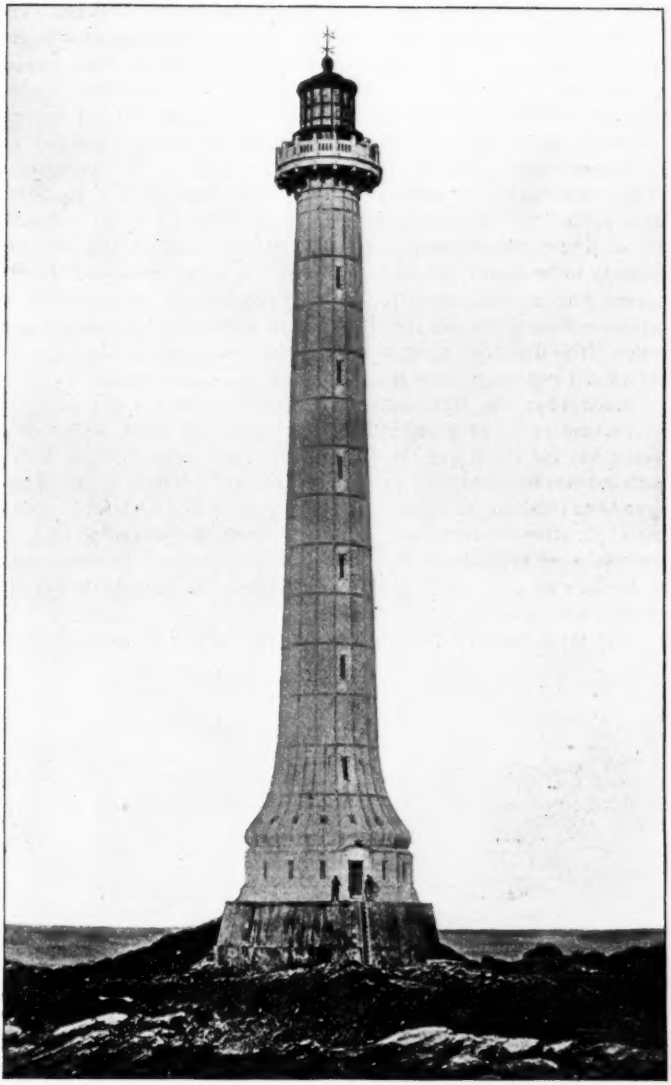


FIG. 22. ROCHES-DOUVRES LIGHTHOUSE (DEPARTMENT OF CÔTE-DU-NORD).

pitch every thirty seconds. The siren mechanism includes two Bénier hot-air engines (Fig. 20) of 9 h. p., operating two high- and low-pressure air-compressors, which may be driven by a direct connection with the motors. A steam pump is used to keep in circulation the cooling water drawn from the sea for each air motor. As about half an hour is required to start the air motors, and as it is sometimes necessary to start the siren promptly upon the appearance of fog, two sheet-iron reservoirs of about three cubic metres' capacity are provided, which are always kept charged with air under a pressure of fifteen atmospheres. A reducing valve enables this storage capacity to be drawn at a constant pressure of three atmospheres, the normal working pressure of the siren. The latter is mounted on a vertical axis, and its velocity of rotation is controlled by a centrifugal brake. The first cost of the "Ruytlingen" was 300,000 francs, and the annual expense of its maintenance reaches 40,000 francs.

Since 1897 the lighthouse department has been experimenting with a new device invented by the able engineer-in-chief, M. Ribère, which has for its object the use of flash-lights operating with Welsbach burners supplied with compressed oil gas. These experiments have been tried on the lightship of the Grand-Banc (Gironde). During 1898, after the tests have been completed, it is expected that, if the results are satisfactory, this system will be applied to the lights at Rochebonne, 33 miles to the west of the Isle de Ré, de By, de Mapon, and de Falais (Gironde).

The great buoy at Dunkerque (Fig. 24), which is the most pow-

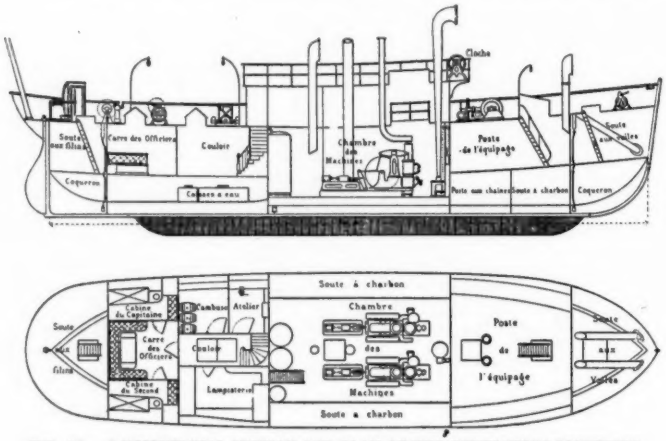


FIG. 21. LONGITUDINAL SECTION AND PLAN OF THE RUYTLINGEN LIGHTSHIP.

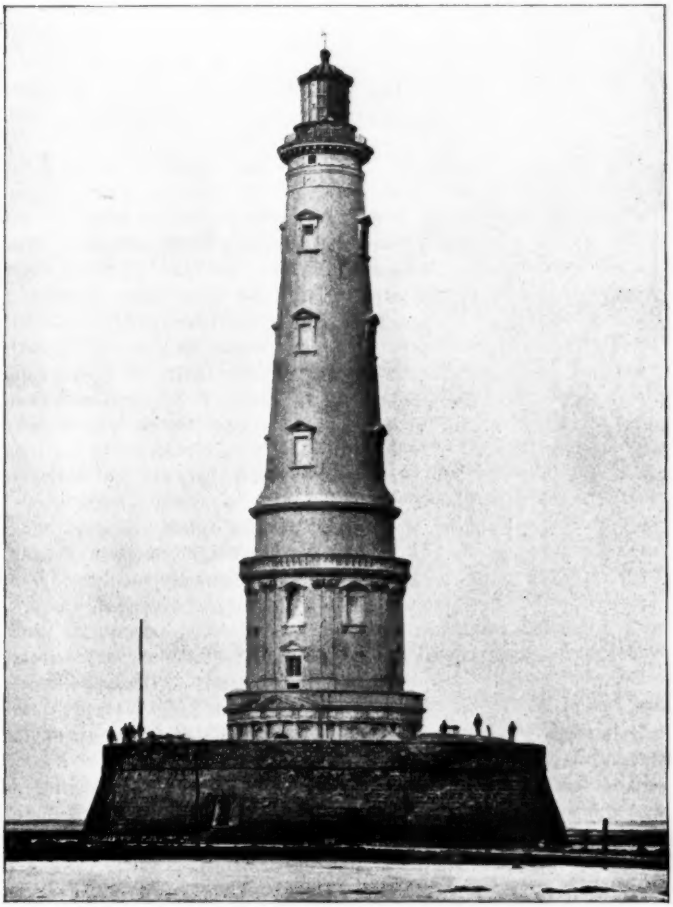


FIG. 23. CORDOUAN LIGHTHOUSE (DEPARTMENT OF GIRONDE).

erful yet constructed, carries an optical system 0.375 metres in diameter, carried on a Cardan, or universal suspension, as is the case with all the French buoys. The light is a fixed one, and only a dioptric lens system is employed. The lantern is made of as small dimensions as possible, and contains a double-tube gas burner, which

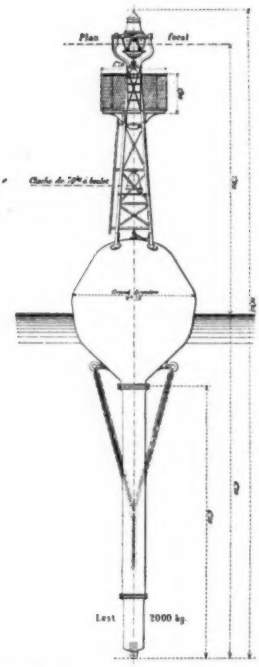


FIG. 24. LUMINOUS BUOY AS USED IN THE HARBOR OF DUNKERQUE.

consumes 120 litres of compressed oil-gas per hour. Especial care has been taken to provide for a proper circulation of air and removal of the products of combustion, in order to secure proper draft and to prevent extinction of the light, as well as to avoid accidents.

The buoy has a capacity of 18 cubic metres and a tail 6.50 metres in length, carrying 2,000 kilogrammes of ballast, the total draft being 9 metres of water. The luminous power is equal to about forty carcels, and the focal plane is about 7 metres above the surface of the water.

The total number of lights of all sorts in service on the coasts of France and Algiers, including fixed, occulted, and flash lights, is 640, among which are 8 lightships and 81 luminous buoys. Along the coast of Tunis there are 37 fixed lights using oil lamps, 10 permanent lights using gas, and 6 oil flash lights.

The principal lighthouses of France, other than those already mentioned, are those of Cordouan and of Roches-Douvres (Côte-du-Nord). At present the total luminous power exceeds 10,000,000 carcels for France and Algeria, and 8,000 for Tunis, of which only 7,150,747 carcels were in service on January 1, 1895. These figures speak for themselves, and bear stronger testimony to the work of the French central service of lighthouses than any words of eulogy, showing, as they do, how completely the engineers,* MM. Bourdolles, Ribière, and de Joly, have maintained the scientific traditions of their predecessors, the Chevalier Borda, and the physicist, Fresnel.

*The author desires to acknowledge the facilities which these gentlemen have placed at his disposal in the preparation of this article.

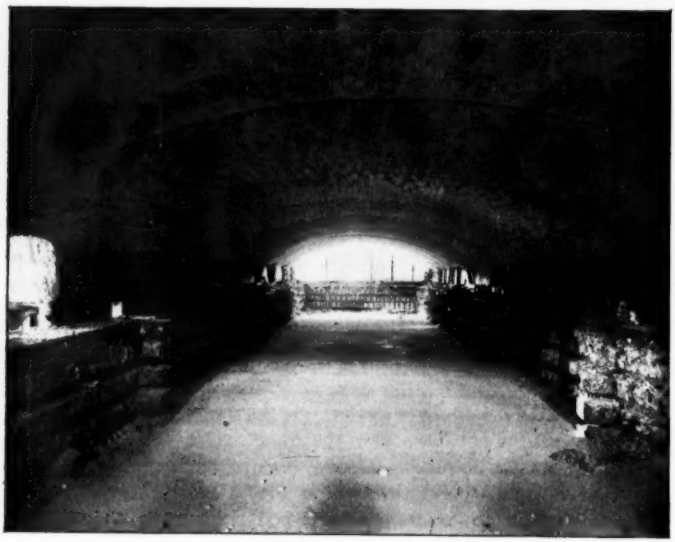
CONTINUOUS OPERATION IN THE MANUFACTURE OF WINDOW GLASS.

By Robert Linton.

THE most important event in the history of the window-glass industry is the introduction of the continuous melting tank furnace, which is now coming into very general use in place of the older pot furnace. For the sake of clearness, let us at the outstart briefly define the two styles of furnace. A pot furnace is a furnace of rectangular plan, containing two rows of large crucibles, in which the glass is made. There are usually eight or ten pots in a furnace. The batch—the mixture of sand, limestone, and alkali—is filled into the pots, decomposed, and melted down into glass, the filling being repeated until the pots are full. Then the glass is cleared, settled, and worked out. The furnace is turning out glass only about a third of the time. A tank furnace consists essentially of an oblong hearth, the "tank," containing a bath of liquid glass heated by overhead firing. Upon this bath of glass the batch is filled at one end and floats slowly down, melting into glass as it goes, and is worked out continuously at the other end. A tank furnace might be called an open-hearth glass furnace. Near the working end of the tank are placed floating bridges of fire-clay, reaching down about a fourth of the distance to the bottom. The glass must pass beneath these before it reaches the working end, and is thus cleared of light impurities floating on the surface and thoroughly mixed. To avoid confusion, we will note that the term "tank," although often applied to the whole furnace, properly applies only to the hearth containing the bath of glass; for the whole furnace the term "tank furnace" should be used.

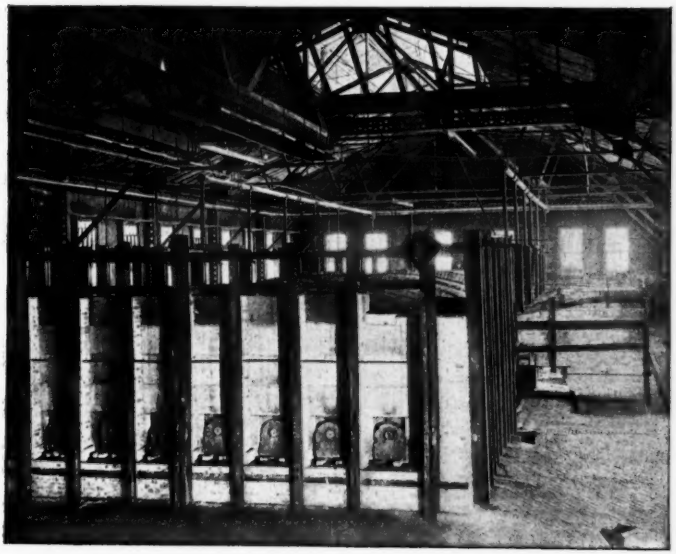
The first tank furnace was built about 1860 by Messrs. Casimir Lambert & Florinflot, window-glass manufacturers, of Charleroi, Belgium. It was very crude in design, and fired directly with coal, after the manner of the pot furnaces of that time. In a pot furnace, however, the pot itself becomes heated, and helps the melting along; as much heat plays around the pots as over them. The outside of a tank, on the other hand, must be kept cool, heat being developed by firing from above. Sufficient heat cannot be developed by means of direct firing, to say nothing about the dirt carried in from the grates. The interest attaching to this first tank furnace is only historic. It failed of any practical success.

It was only through the development and application to metallurgical operations of gas-firing that the tank furnace could come into use at all. This is but one instance of the far-reaching influence of gas firing upon glass manufacture. It has entered all departments where heat is required, effecting great improvements. The direct coal-fired plants of twenty years ago cannot compete, either in quality of product or economy of operation, with the gas fired plants of the present time. Producer gas is the kind of gas ordinarily used for firing glass furnaces,—a comparatively weak gas, the lowest, in fact, of all fuel gases in thermal value. Made by passing a jet of steam and air through a bed of coals, the result is a mixture of hydrogen, carbonic oxide, and the volatile hydrocarbons of the coal as combustible and heat-producing constituents, and carbonic acid and nitrogen as non-combustible constituents, serving merely to dilute the gas. A good producer gas will contain but thirty or forty per cent., by volume, of combustible elements. It burns feebly in the air, and requires to be burned hot, and fed with hot air when used as fuel. The problem of



THE INTERIOR OF A TANK FURNACE, NEARLY EMPTY.

Taken at the end of a year's run. The blocks, which were made from American clay, had been in place from two to seven years, except the top course, which had been in for seven months.

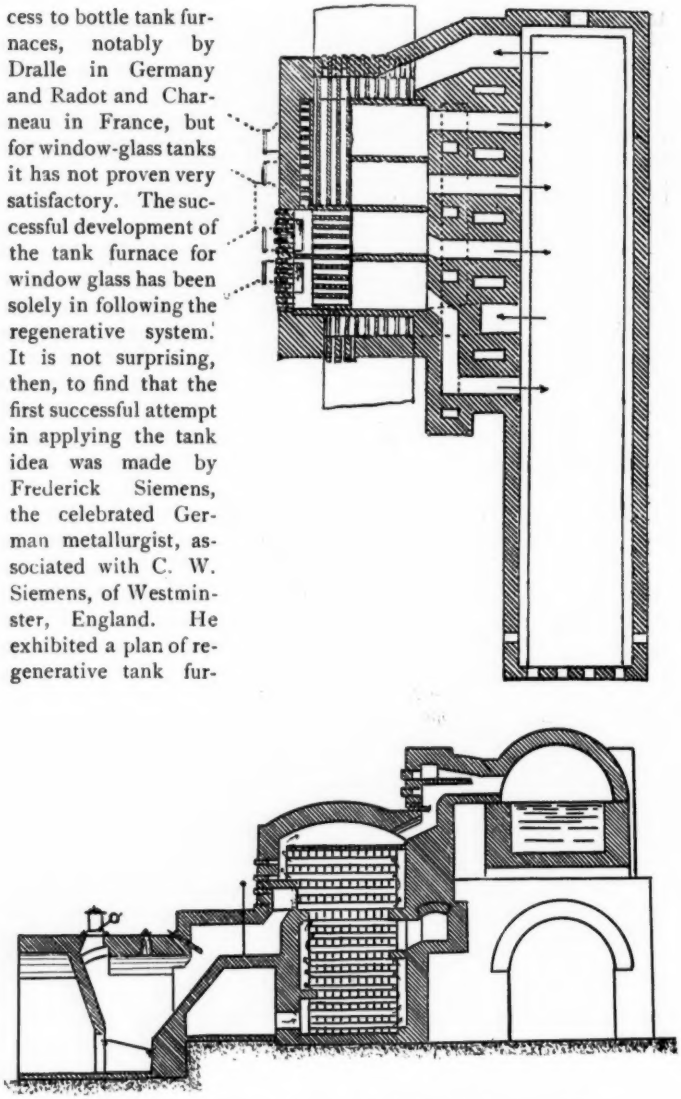


SQUARE-FRONT TANK FURNACE IN AN AMERICAN PLANT.

its successful use is, therefore, chiefly one of proper preheating, utilizing for this the waste heat of the spent products of combustion after they leave the furnace.

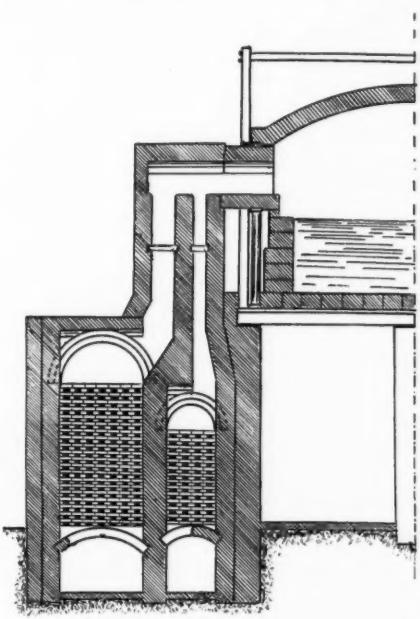
This method of preheating may follow either the regenerative or the recuperative system. A regenerative furnace has two pairs of chambers—the regenerators—filled with loosely-laid fire-brick. The air and gas enter the furnace through one pair, and the products of combustion pass to the stack through the other. The direction of the flame is reversed periodically, so that each pair of regenerators is in turn heated by the outgoing waste gases, and imparting its stored heat to the ingoing elements of combustion. In the recuperative system there is no reversal of the direction of the flame. The recuperator consists of two sets of tortuous flues, separated by thin partitions. The outgoing gases pass through one set, and the incoming air through the other. The heat of the former is imparted to the latter through the thin flue walls. The gas is usually not preheated, but the gas producers are set close to the furnace, so that the initial heat of the gas in the producers is not lost between the producers and the furnace. The recuperative system has been applied with some suc-

cess to bottle tank furnaces, notably by Dralle in Germany and Radot and Charneau in France, but for window-glass tanks it has not proven very satisfactory. The successful development of the tank furnace for window glass has been solely in following the regenerative system. It is not surprising, then, to find that the first successful attempt in applying the tank idea was made by Frederick Siemens, the celebrated German metallurgist, associated with C. W. Siemens, of Westminster, England. He exhibited a plan of regenerative tank fur-



PLAN AND CROSS SECTION OF CHARNEAU RECUPERATIVE TANK FURNACE.

nace at the Vienna Exposition of 1873, and from that time devoted considerable attention to its development. His experiments and his success were mainly in the manufacture of bottles. This may be due to the fact that in Europe bottle glass is, as a rule, more fusible than window glass, inferior and more fusible materials entering into its composition for the sake of economy; and it was therefore better adapted for experiments with a new-style furnace. The Siemens Company at Dresden has been very successful in the development of the bottle tank furnace and in the manufacture of bottles. At its immense plant it has a number of furnaces in operation, entirely circular in shape,—a style that deserves the attention of other bottle manufacturers.

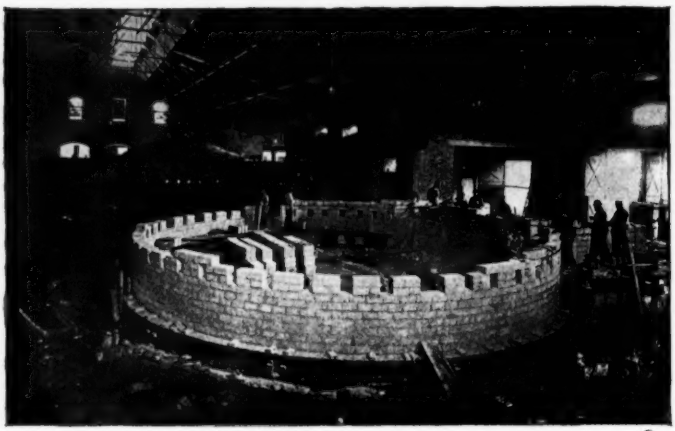


CROSS SECTION OF PORT, NECK, AND REGENERATOR OF BAUDOUX-PAGNOUL TANK FURNACE.

The first manufacturers of window glass to use the tank furnace successfully were Pilkington Bros., of St. Helens, England. They discovered and corrected many defects in the original Siemens construction, and developed a very efficient furnace, though of small size. About the same time the Belgian and French manufacturers began to take up the matter. The history of the development of tank construction on the continent naturally associates itself with the names of Eugene Baudoux, in Belgium, and Emile Gobbe, in France and later in Belgium. In 1884 M. Baudoux built a furnace with a capacity of thirty-six blowers, and, immediately afterwards, another of forty-five blowers' capacity. This was a radical departure from the small tank furnaces that had been operated previously. By increasing the size the economy of operation was much increased. Indeed, so efficient were his

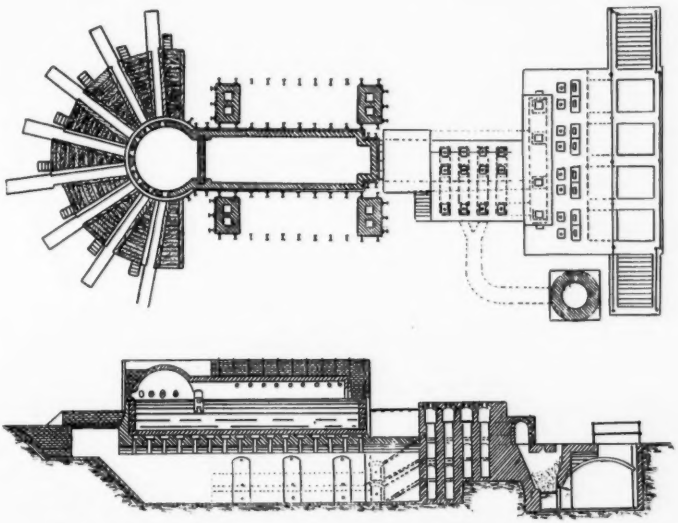
CIRCULAR REGENERATIVE TANK FURNACE FOR GLASS-BOTTLE MANUFACTURE. SIEMENS CO., DRESDEN.

furnaces that they excited bitter opposition on the part of the workmen, on account of their saving of labor and fuel, and in the general strike of 1886 a mob destroyed his factories. It is said that, had M. Baudoux fallen into the hands of the mob, his fate would have



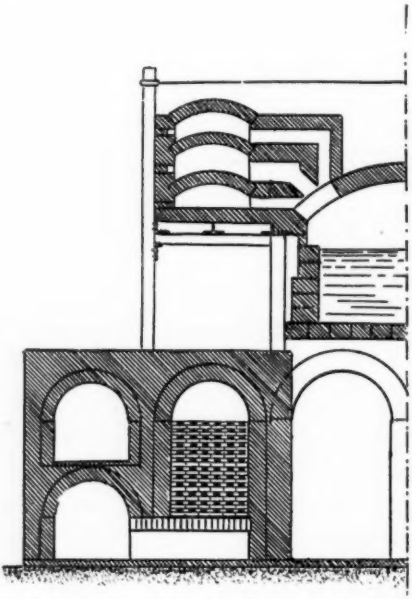
CIRCULAR REGENERATIVE TANK FURNACE UNDER CONSTRUCTION.

been that decreed by a certain Babylonish king against all who would not fall down and worship him. It is characteristic of the tremendous energy and determination of M. Baudoux that he began, without delay, erecting new works even superior to the old ones. His plant has been in successful operation ever since. No one is entitled to more credit in the development of the tank furnace than he. He has made many and expensive experiments, and has not kept the results secret, but has allowed others to benefit by them. The very destruction of his factories served more perhaps than anything else could to bring the tank furnace to the notice of glass manufacturers. It is



PLAN AND LONGITUDINAL SECTION OF 24-BLOWER GOBBE TANK FURNACE.

worthy of note that his most recent experiments have been with a tank furnace of extremely small size,—just the other extreme from his early experiments,—hoping to determine the limits of size in this direction and the relative efficiency and economy of large and small tanks. The Baudoux tanks follow partially the original Siemens lines, but there are many improvements in the details. The style of construction is familiar in the United States under the name of the Pagnoul tank furnace. M. Pagnoul was associated with M. Baudoux in the construction of his furnaces, and afterwards joined M. Gobbe in forming the firm of Gobbe & Pagnoul. M. Gobbe has devoted more time to



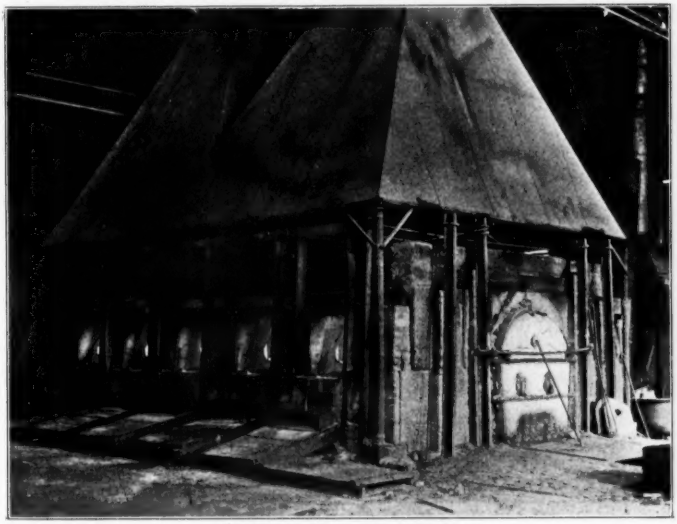
CROSS SECTION OF PORT AND REGENERATOR, GOBBE TANK FURNACE.

small-size furnaces, and has developed a construction which, for a capacity up to about thirty-six blowers, is unsurpassed by any yet designed. As the tendency in the United States has been to build extremely large furnaces, Gobbe & Pagnoul have used the Baudoux-Pagnoul construction in the furnaces they have built there.

More than thirty window-glass tank furnaces had been built in Europe before one was built in the United States. Conservative American manufacturers hesitated to assume the large initial expenditure for tank plants, which, while they might bring about some economy of operation, might also produce glass of inferior quality. The experiments in Europe were watched, as far as was possible from a distance, with much interest. It is less than ten years since the matter was taken up seriously by a few American manufacturers who were convinced that the success claimed for the tank furnace was a reality. An especial encouragement was afforded in the discovery in the United States of natural gas in abundant quantities for manufacturing purposes. Natural gas is the fuel *par excellence* for glass-melting, and especially for the tank furnace. The whole of it is highly combustible. It is clean, powerful, and easily controlled. For a time the supply continued to be abundant, but it is nearing exhaustion now, and many plants have been obliged to alter their furnaces for the use of producer gas, which, when properly controlled, will make just as good glass as natural gas, although it is not nearly as convenient. Though aided by the convenience of their fuel, those American manufacturers who took the initiative had, to a certain extent, to go through the same experimental difficulties that the Euro-

pean manufacturers met. Their experience was not always successful; still it was satisfactory enough to demonstrate that a tank furnace, properly constructed and properly controlled, will produce as fine a quality of glass as was ever made in a pot furnace, and at considerable economy of fuel and labor. The tank furnace soon began to come more rapidly into favor, and at present more than a score are in operation in the United States, producing more than sixty per cent. of all the glass manufactured in the country, including the best and most popular brands. Each year sees the firing up of new ones, and the abandoning of old pot plants. The experience already gained by manufacturers renders it possible now to designate pretty accurately the general lines on which a tank furnace should be built to give a good product and economical operation, so that the building of a tank furnace need not now be considered an experimental investment.

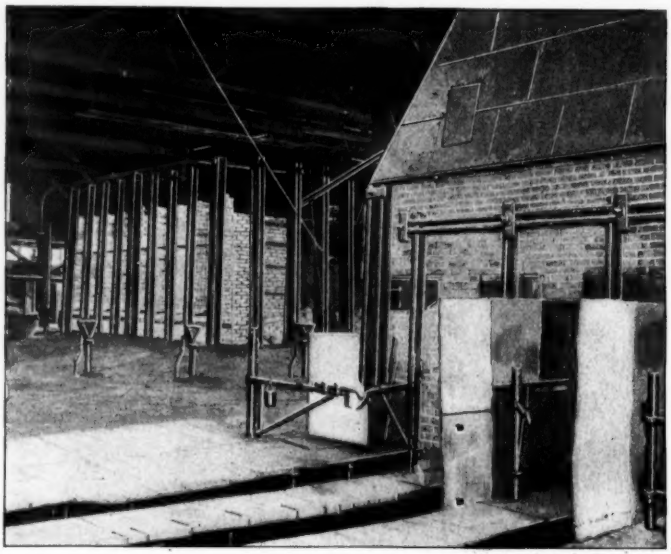
After all, the work that a tank furnace has to do does not differ from that of a pot furnace. One is in continuous operation, the other intermittent. That is all. The metallurgical operations and chemical reactions are precisely the same in the one case as in the other, and must be provided for alike. It takes a certain time to make a melt in a pot furnace, and, if an attempt be made to hurry it, the glass will be spoiled. Likewise it takes a certain time to melt glass in a tank furnace, and this is regulated by the length of the furnace



A REGENERATIVE POT FURNACE.

and the rapidity of the current of the batch. If a furnace be run beyond its capacity, the melting batch is pulled down before it has had time to be made into good glass. To make good glass regularly the tank furnace must be kept within its capacity.

The first tank furnaces that were built were designed according to the idea that, since all the heat is applied from above, the melting and fining take place entirely on the surface. The capacity of the tank, therefore, was made proportional to its superficial area, and depth was neglected as a factor. Siemens soon observed that this position was not altogether correct, and that it was necessary to have a layer of glass to melt on, not only to preserve the bottom of the tank, but also to attain good results in melting. He took the view that glass fines as it sinks beneath the surface, and that the depth of the tank is necessarily considerable if the glass is to be well fined. He took out a patent in 1879 on tanks more than eighteen inches deep. Fining, however, has nothing to do with either depth or direction, but merely with heat. The deep tank does not facilitate fining any more than melting, but aids both in storing heat and giving it back to the batch from below; it helps also to preserve an even



TANK AND BLOW FURNACES IN A PENNSYLVANIA GLASS WORKS.

A ROUND-FRONT TANK FURNACE.

melting environment for it. M. Emile Gobbe went much further in elaborating the idea experimentally and theoretically. He ascertained that the calorific rays traversing the bath of glass undergo a diminution in intensity amounting to $\frac{5}{1000}$ per centimeter, and reasoned that, by increasing the depth of the tank to a point where the glass becomes solid or practically so on the bottom (about two meters), all the thermal rays will be absorbed and given back to the furnace to assist in the melting. He also concluded that tanks of the same superficial area and different depths have productive capacities proportional to their depths, and that the capacity of a tank is, therefore, proportional, not to its superficial area, but to its cubical contents, laying down the rule that not more than eight to ten per cent. of the total charge of the tank should be worked out in twenty-four hours. Actual practice has not often reached as high an efficiency as this, and has shown that it is best to take into account both superficial area and cubical contents in determining the capacity of a tank. They are equally important factors, varying somewhat with the style of tank furnace built. The average of a number of European factories where a high efficiency is generally attained gives a superfi-

cial area of twenty-six square feet per blower, and a daily output of seven and one-half per cent. of the total charge of the tank. Mr. Gobbe's small tanks have been very successful in Europe. In addition to a well-proportioned tank, he has also designed carefully his firing, which is, after all, the vital part of a glass-melting furnace,—the part that does the work. The construction and disposition of ports, necks, regenerators, flues, valves, and stack must be such as to shoot down upon the batch a sheet of clear, hot, keen flame. A temperature of about 2,600° F. is required. In the Gobbe tank furnace a number of small ports enter through the crown. The sheet of flame is nearly continuous, and has a good pitch to the furnace.

In the United States there is much dissimilarity in style of construction. The experiences of different manufacturers have not led to identical conclusions. All are aiming at greatest efficiency, but all do not follow the same ideas in modelling their furnaces to secure it. Notwithstanding these differences in structural details, the furnaces are generally very efficient, and are producing window glass inferior to none made anywhere in the world. An accurate comparison of the efficiency of the American and European plants would be very difficult to make, as conditions of labor and market especially, and other conditions in less degree, differ widely. There is a uniform efficiency in the European plants, a studied and systematic economy, an intelligent adaptation of their plants to the requirements of their situation. One point is worthy of note. In Belgium all the glass is blown over the tank, the surplus heat of the furnace being used for the necessary reheating of the glass in blowing. In the United States separate furnaces—the blow furnaces—are kept up for this, entailing considerable expense for operation and maintenance. In point of size the United States have gone much beyond the European construction. M. Baudoux's forty-five-blower tank is still one of the largest, if not the largest, in Europe. This is an ordinary capacity in the United States, and there are furnaces now in operation of sixty blowers' capacity. Such a furnace represents in itself a capacity larger than that of any entire plant in operation previous to the introduction of the tank furnace.

The efficiency of the regenerative tank furnace, expressed in terms of the percentage of the total heat potentiality of the fuel used and actually absorbed in the glass melting, shows a large gain over the pot furnace. For window-glass furnaces the latter style shows an efficiency of four or five per cent.; the tank furnace, on the other hand, ten or twelve per cent., based on the use of a good producer gas made from bituminous coal. A still greater efficiency may be expected to result from further experience and improvements.

EVOLUTION IN CENTRAL-STATION PRACTICE.

By Charles F. Scott.

THE principal functions of an electric power system are the transmission of energy from a power station to the place where the power is to be supplied—the subdivision into small units of power generated in large quantity, and the utilization of the power through motors, lamps, or other devices.

The first of these, the function of electricity as a carrier or conveyor of power, is the one which has most to do in determining the electrical characteristics of the system.

The controlling element in electrical transmission is pressure, or electro-motive force. The flow of electricity, like the flow of water, requires a much smaller conductor for delivering a given amount of energy if the pressure be high and the current small. Again, both with electricity and water, the greater the distance, the larger must be the conductor, if the same power is to be transmitted with the same loss. To transmit over a great distance, therefore, it is necessary that the pressure be high in order that the dimensions of the conductor may be small and its cost low, and, for given conditions of loss and cost, the greater the distance, the higher must be the pressure.

On the other hand, in the utilization of electric current, either for motors or for lighting, it is essential that the pressure shall not exceed certain limits, within which the apparatus can be cheaply constructed and economically and safely operated.

The conflicting demands upon the electrical system are, therefore, that it shall transmit current at a high pressure, and supply current for use at a low pressure. These conditions are met either by a compromise, involving the choice of the highest electro-motive force which is permissible for the apparatus in which the current is to be used, and its transmission at this voltage, or by adopting a system in which a transformation can be made between a high pressure employed in transmission and a low pressure for use.

The essential difference between alternating current and direct current is that the first readily permits of transformation from one pressure to another in a simple, cheap, and economical way, while the direct current does not admit of such transformation.

The direct-current system was the first in general commercial use. The first central stations employed this system, and it has been developed and exhaustively improved. The early direct-current stations found their field in lighting a compact territory adjacent to the

station. The 220-volt three-wire system, which was suitable for supplying 110 volt lamps, was found to cover a limited radius without excessive cost for conductors.

The direct-current system is confined to a comparatively small area, which must naturally be a compact one in order to make the operation of a large station feasible. A system of this kind is not adapted to serving extended areas, such as are found, for example, in small scattered towns and outlying districts of cities, where there may be a considerable field for incandescent lighting.

The early alternating-current stations immediately entered this field. Their remarkable adaptation to the requirements of such a service is indicated by the fact that there is scarcely a town of average size which does not have its alternating-current central station; and the larger cities, with extensive direct-current stations in their compact central portions, are usually fringed with alternating-current circuits.

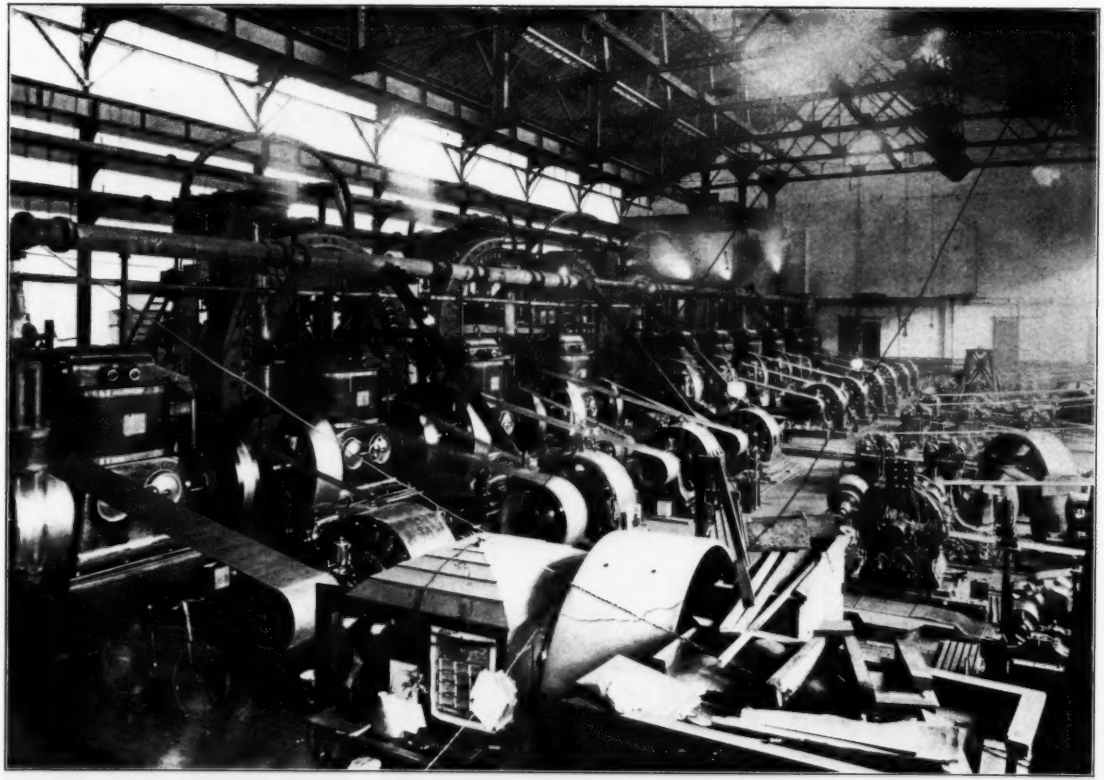
The alternating-current plan for general distribution employs 1,000 or 2,000 volts in the distributing circuits,—a voltage ample for distribution over distances of a few miles. The alternating current is also employed at higher voltages at greater distances, where longer transmission is necessary, as it is often from a water power which lies from ten to fifty miles from a city.

The early alternating current stations were, in most cases, used for comparatively small loads and for distances which were moderate for the voltages employed, so that a small loss in the conductors was secured at moderate cost. The advantages of the alternating current over the direct current, for this field, were so very marked that little attention was given to the loss in the circuits. It is not easy, therefore, except in some of the most recent installations, to find alternating-current stations which may be considered ideal, or constructed according to the best standards, whereas many of the larger direct-current stations exhibit the best results, probably, obtainable.

Within the last few years the alternating-current practice has received a vital modification in the introduction of polyphase, instead of single-phase, currents.

The early single-phase stations were devoted almost exclusively to incandescent lighting, and a most serious limitation of the single-phase system was that it had no motor by which it could serve power. The polyphase system accommodates the alternating-current motor, so that both light and power may be furnished by the same system.

The unique feature of the polyphase system is its flexibility. The pressure can be raised almost indefinitely for transmission, and reduced for consumption. The number of phases can be transformed at will, and it admits of ready conversion into direct current, at any voltage.



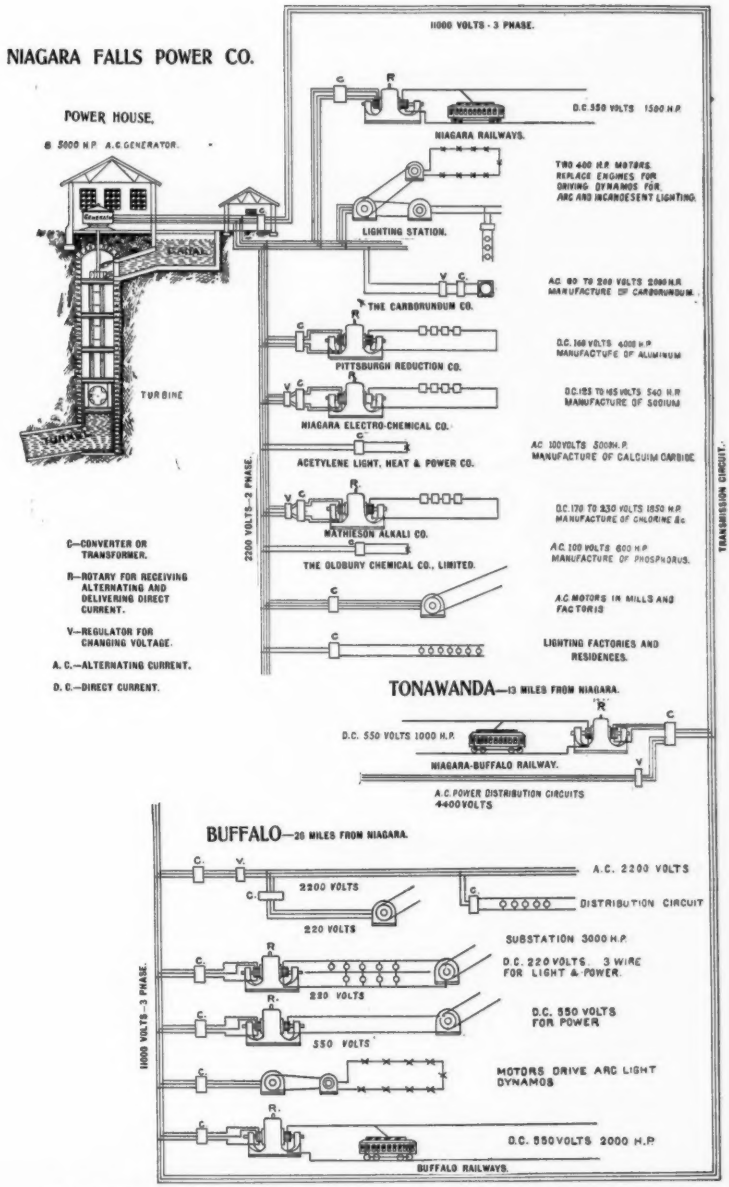
THE REVOLUTION IN CENTRAL-STATION APPARATUS. THE BELT-DRIVEN MACHINES ARE BEING REPLACED BY THE LARGE ALTERNATORS SHOWN IN THE REAR.

The possibilities of the alternating-current polyphase system were pointed out long ago. The variations, transformations, and wonderful flexibility, which were seen as possibilities, have been taking form during a dozen years of evolution in the design and construction and the methods of operating electrical apparatus, until these things have become practical realities. We need no longer point to diagrams of imaginary circuits and give theoretical explanations of what may be, but we can see what is now operating and is now being constructed. Some of the largest and most important installations which have been put into operation recently, as well as many of the largest undertakings which are at present contemplated, employ the polyphase alternating-current system.

It may be remembered that, some six or eight years ago, there was much discussion as to the system which should be employed in the large plant proposed for Niagara Falls. This plant was to be distinctively a power plant, and a large part of the power was to be used in the immediate vicinity of the generating station. The direct-current system had its strong advocates, who were very sceptical as to the applicability of the alternating current in a large power plant, in which there would certainly be a demand for a wide variety of service.

One needs to recall incidents of this kind to appreciate how rapid has been the advancement, and how complete has been the electrical development, of the last few years.

The various transformations of the current from the two-phase generators of the Niagara Falls Power Company are shown in the accompanying diagram. All the power from the 5,000-h. p. generators is delivered as two-phase alternating current, at 2,200 volts and a frequency of 25 periods per second. Four wires are carried directly from the generators to the surrounding industrial establishments. Current is transformed to low voltage, and then converted into direct current at 550 volts, for railway service. It is also converted into direct current at 160 volts, for use in the production of aluminum. At other places it gives direct current at variable voltage, adjustable at will from 125 to 165 volts in one case, and from 170 to 230 volts in another, to meet the varying requirements of electro-chemical processes. It is used as alternating current at low voltage for producing intense heat in chemical manufacture; in some places at a constant voltage, and in another at variable voltage. Regulators are provided by which 1,000 h. p. can be delivered in the form of 3,750 amperes at 200 volts, or 9,400 amperes at 80 volts, or any intermediate current and corresponding voltage. The current supplies induction motors, of 400 horse power and smaller sizes, some for replacing engines in a



TRANSFORMATIONS OF CURRENT FROM TWO-PHASE GENERATORS AT NIAGARA FALLS.

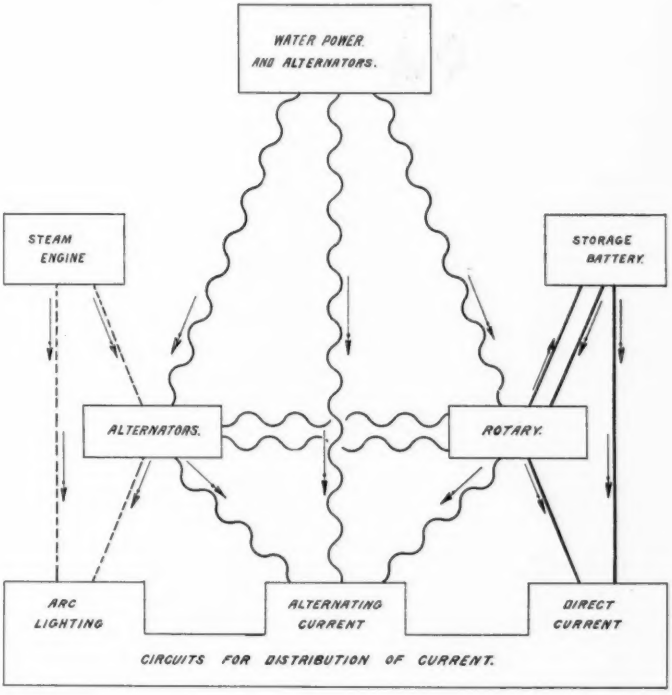
lighting station, others for doing various work in factories, sometimes directly at 2,200 volts, sometimes at low voltage.

The current is transformed into three-phase current at 11,000 volts for transmission to greater distances. At Tonawanda there are rotaries for delivering direct current to the Niagara & Buffalo railway, and there are distribution circuits for supplying electric current for power and light.

At Buffalo current is reduced in pressure and converted into direct current, at 550 volts, for street railways and for stationary motors; it is converted into direct current for 220-volt three wire distribution; it runs motors which replace engines in lighting stations for driving dynamos for arc-lighting and for high-frequency incandescent lighting; it runs motors in grain elevators and various industries, and supplies incandescent lighting.

We are not now considering the economic influence of electricity in touching manufacturing and industrial operations in so many and so varied ways, or the newness of the processes and the far-reaching importance of the products which have been made possible by the supply of large quantities of cheap electric power, or yet the magnitude of the engineering projects which are involved in this great power plant; we are considering simply the electrical system by which one set of bus bars is supplying electric power in nearly every form, and for practically every purpose to which electricity is industrially and commercially applied.

The transformations to which the polyphase alternating current is amenable, in a large plant, are seen at Hartford, Conn. There are two sources of power—a water power, ten miles from the city, which drives alternating-current generators delivering current through raising transformers to a three-phase 10,000-volt transmission circuit, and a steam engine, located in the city. This engine drives a countershaft, from which are belted a number of arc machines. The countershaft is connected to an alternating-current machine, which may be driven by the engine for supplying power to the alternating circuits; this machine, however, may receive current from the transmission line, and run as a synchronous motor, driving the countershaft, and arc machines. There are rotary transformers in the city, which receive alternating current either from the water-power station or from the steam station, and deliver this power in the form of direct current, which is supplied either to the 220-volt 3-wire distributing system, or to a large storage battery. The storage battery in turn may serve as a source of power, from which current may feed into the direct-current distributing system; or, passing through the rotary, it may appear in the form of alternating current, which may either sup-



PATHS OF POWER AT THE HARTFORD PLANT.

ply the alternating-current distributing circuits, or pass to the synchronous motor, and be used for arc lighting.

Either the water power or the steam engine, therefore, may supply either the arc circuits, the alternating-current circuits, the direct-current circuits, or the storage battery. The storage battery may, in turn, supply power to any of the three classes of distributing circuits. The storage battery is charged when the load upon the distributing circuits is small, and it discharges when the demand is greater than the capacity of the water-power station, thus enabling the turbines to carry a load some fifty per cent. above their maximum output. The battery is also a useful regulator for both direct and alternating cir-

ONE OF THE EARLIEST COMMERCIAL ALTERNATORS. A 300-LIGHT MACHINE OF 1886.

cuits, to prevent variations of voltage with varying load. The steam plant is a reserve.

These interesting relations may readily be illustrated by a diagram, which happens to take a symmetrical form, and which illustrates, in a striking way, the combination into one flexible system of classes of work which are, ordinarily, absolutely distinct, and it is interesting to note that the lines in the centre of the diagram, which bind together the different elements in the system, represent the polyphase alternating current.

In the past development of electric work each set of conditions has dictated certain requirements, and given rise to a specific system.

The usual types of city central stations are as follows:

(1) 220-volt three-wire direct-current system, for lighting and motors.

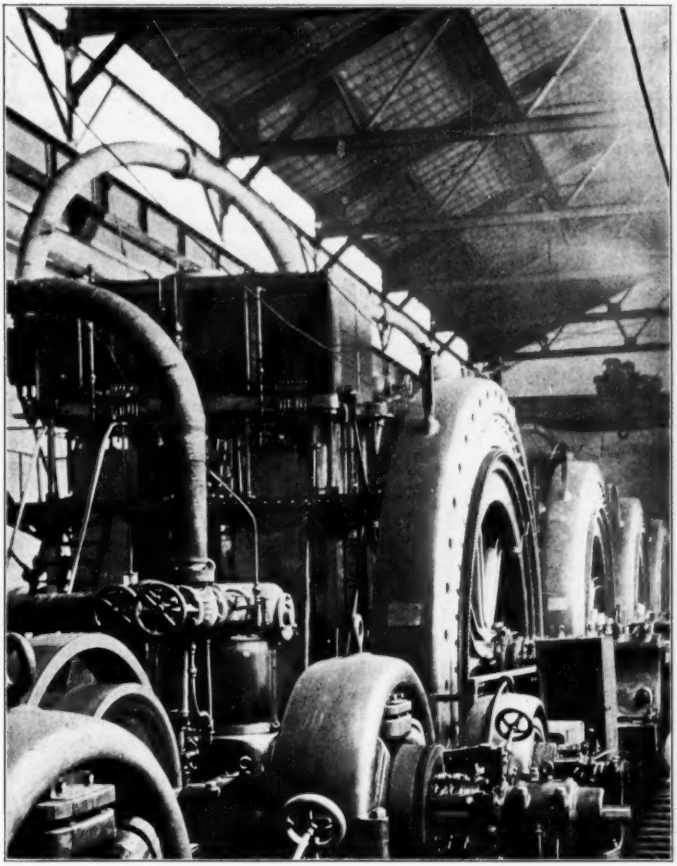
(2) 500-volt direct-current system, for street railway.

(3) 500-volt direct-current system, for stationary motors.

(4) Direct-current series system, for arc-lighting.

(5) Alternating-current single-phase system, for lighting.

(6) Alternating-current polyphase system, for lighting and power.



A MODERN CENTRAL STATION. FOUR 1500-KILOWATT TWO-PHASE ALTERNATORS, DIRECT-DRIVEN BY VERTICAL ENGINE.

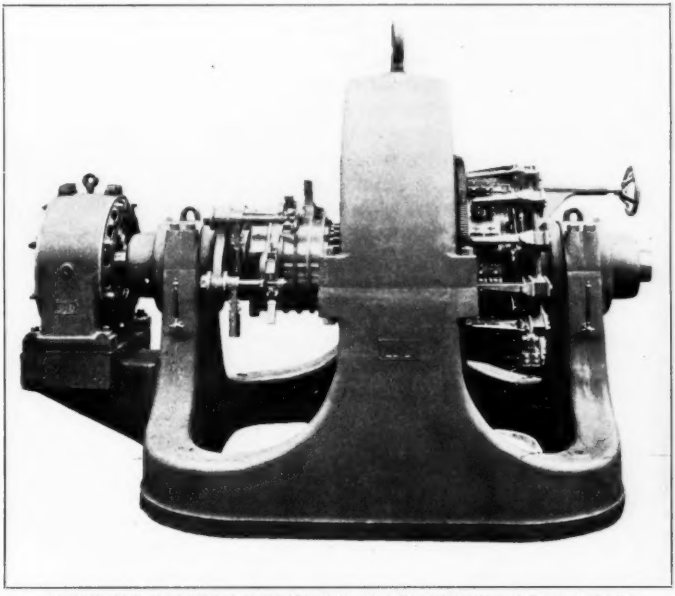
It will be noted that, omitting for the present the last one, the various systems named are exclusive, both in the generation of current in the circuits to be employed and in the kind of service rendered. It is true that both 220 and 500 volts are used for supplying direct current for power purposes; but the two systems are distinct, in that one of them is combined with lighting and the other can extend to a much greater radius.

It is true that both alternating current and direct current are adopted for lighting, although the direct current is limited in its radius, while the alternating current is practically unlimited; nevertheless, the various kinds of work require different types of dynamos, so that the same dynamo cannot supply either of several kinds of service. In general, this leads to the use of separate engines for each kind of work. The circuits from the station, where several of the systems are operated in one station, must be individual for each class of work.

The inefficiency, complication, and cost of operating some half-dozen different kinds of electric systems in this way are so apparent as to need no passing comment. The ideal of the central-station manager is to do away with small engines, small dynamos, and promiscuous circuits, to gain the simplicity and efficiency of large engines and generators, and to reduce the number of circuits from the station. Moreover, in many of the larger cities, the area is so great that 220-volt and 500-volt distribution require a considerable number of stations distributed throughout the city. The stations must be located in the centre of the districts which they supply, and this requires that power stations shall be placed in localities where they are undesirable, where real estate is expensive, where fuel must be hauled in wagons, and where condensing water is not to be had. The same reasons which combine to make large engines and large dynamos desirable, in a single station, make it also desirable to combine the power plants of many stations into one large station. A power station, placed in a city, must conform to the surrounding conditions; outside, it may be designed for the highest convenience and economy.

It is evident, from the illustrations which have already been given, that the means for combining the whole service of a large station into a single unit—or, again, for combining the power plants of many scattered stations into one single power plant—are made possible through the alternating-current polyphase system. The 220-volt 3-wire direct-current service can be supplied readily, through rotaries in sub-stations, located at the centers of distribution and supplied from a distant power plant. The 500-volt direct current for railway service can be similarly supplied. The same method may be used for obtaining direct current at 500 volts for stationary motors. Better, still, alter-

nating current can be used directly for supplying induction motors. The direct-current arc machines can be driven by alternating-current motors, located in the sub-stations, or they may be placed directly in the main station with the generators. In the latter case, the polyphase current is not used for transmission, but serves as a convenient means for conveying the power from a large engine to a considerable number of small machines. In many cases, however, this system of arc-lighting can be replaced by the alternating-current arc lamp, which has points of decided advantage over the direct-current lamp.



ROTARY FOR RECEIVING ALTERNATING AND DELIVERING DIRECT CURRENT.

The alternating current may be used for the service that a single-phase system has been meeting, not only in distributing through distant scattered districts, but also in compact centers. The use of the alternating-current motor, and the construction of large and efficient transformers, have taken away much of the advantage which was formerly possessed by the direct current over the alternating current for distribution in compact centers, and the alternating current and direct current are close competitors for the supply of electric power in compact districts. So closely are the two balanced that a choice between them cannot be made without a specified reference to the local

conditions, designed to determine the relative importance of the various characteristics in which the two systems differ.

The polyphase generator, however, is unaffected by considerations of this kind. It can supply either system of low-tension distribution; or, if the conditions demand, it can supply both simultaneously.

The polyphase generating system, therefore, permits the adoption of any or all of the following kinds of service, and, if demanded, it may deliver current to all kinds of service simultaneously:

220-volt direct current from rotaries and sub-stations, for light and power.

500-volt direct current from rotaries and sub-stations, for street-railway and stationary motors.

Low-voltage polyphase distributing circuits, supplied from lowering transformers through secondary mains, for light and power.

Low-voltage single-phase distributing circuits, for lighting.

Alternating current by isolated transformers, either polyphase, for light and power, or single phase, for lighting only.

Arc lighting, either from constant-potential direct-current or alternating-current circuits, or from arc machines driven by motors.

Special service requiring alternating current or direct current at any voltage.

The principal advantages to be gained by employing one main power station, in the operation of an extended system requiring distribution of direct current from a number of stations, are exhibited in the following table, showing the factors bearing directly upon the cost.

Table Showing Principal Items of Cost which are Increased or Decreased when a Main Power Station and Sub-Stations Replace Several Power Stations.

I. Costs which are increased by operation from a single station. High-tension line from power station to sub-stations. Raising and lowering transformers for high-tension line. Rotaries in sub-stations.

II. Costs which are reduced by operation from a single station.

Real estate: A large station, where land is cheap, and small sub-stations, where it is dear, replace several steam stations where real estate is high.

Steam plant: A single station has larger units of less aggregate output, as the per cent. of reserve apparatus is reduced. Condensing engines usually replace non-condensing.

Generators. A single station has larger units, of less reserve capacity. The same generator may be used for any kind of service. Different types of generators are not required for maximum output and reserve for each kind of service.

Fuel. A single station in the suburbs can usually use a cheaper grade of coal, with less cost of cartage, and will require fewer pounds per horse power, as engines may be condensing and apparatus is usually more efficient. (This is partially offset by losses in sub-station apparatus.) If water power be available, the cost of power may be greatly reduced.

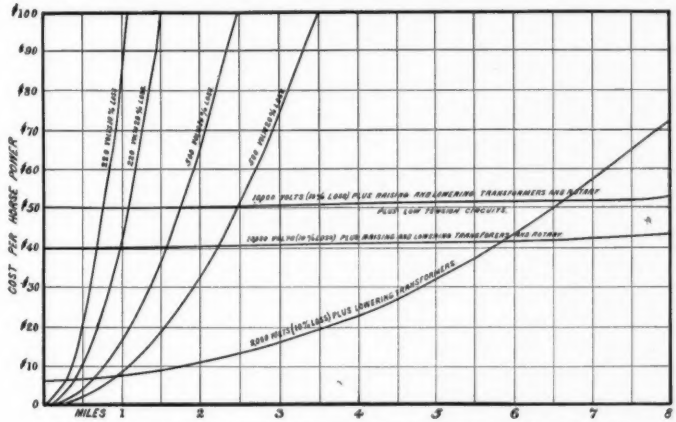
Attendance. A single station and several sub-stations require less attendance than several complete steam stations.

Distribution circuits. The number of sub-stations can be made greater than the number of steam stations which they replace. This reduces the length and cost of the distributing circuits.

The general relation between the first costs of different systems for conducting power from the generator to the consumer is shown by the accompanying curves. These curves are, of course, only approximate; the cost of conductors has been taken at about 15 cents a pound for copper, without reference to insulation; no allowance has been made for the middle wire of the three-wire system, and the cost of apparatus depends largely upon the size of the units used.

The cost for copper for 220-volt transmission and 10 per cent. loss is seen to be $21 per horse power for one mile and $85 for two miles. The cost is half as great when the loss is 20 per cent., but the distance for a given cost is increased only 40 per cent.

The cost for 2000-volt transmission includes a constant representing the lowering transformers. The curve does not include the secondary conductors from the transformers. If the distance be short,



CURVES SHOWING RELATIONS OF FIRST COST OF DIFFERENT SYSTEMS OF ELECTRIC-POWER CONDUCTION.

the cost is small. The lower curve for rotaries includes the cost of transformers, rotary, and 10,000-volt circuit. The upper curve includes the direct-current distribution circuits, assumed to have an average length of one-third of a mile, if the voltage is 220, and three-quarters of a mile, if the voltage is 500,—the loss being 10 per cent.

It is seen that the direct-current transmission is cheaper to install than the 2,000-volt alternating current with transformers, if the distance be less than about a quarter of a mile (the voltage being 220) or two-thirds of a mile (the voltage being 500). The cost of copper for 2,000 volts becomes excessive when the distance exceeds a few miles; for greater distances a higher voltage should be used.

The curves representing the rotary sub-stations show a high first cost. This can be justified only by economies in operation. A comparison between these curves and the 2000-volt curve for the alternating current throughout shows the advantage of the alternating-current distribution over that by direct current through sub stations. Besides the reduction in first cost, the attendance at sub-stations is abolished, and the efficiency is increased.

The comprehensive polyphase system is not a new one, which discards all that is old, but it enables a combination into one system of the best in all others. This result is not so much the immediate outcome of novelty or invention, as of adaptation and engineering. The electrical developments of the last ten years are due not so much to the inventor as to the engineer.

The direct current is comparatively simple in theory, and was for a time far in the lead of the alternating current. The alternating current, however, complicated and intricate in its theoretical treatment, mysterious in its phenomena and interactions, is much the simpler in apparatus. The generator is a simpler machine, as it is burdened with no commutator; the transformation from one pressure to another is effected in an apparatus without moving parts, possessing as high an efficiency as that of any instrument by which energy is transformed; and the alternating-current motor, so long a phantom and stumbling-block, has now far surpassed its direct-current rival in mechanical simplicity, and general merit for almost every kind of service.

And the direct current, which once upon a time looked with disdain and ridicule upon its adversary as a feeble infant, doomed soon to perish by its own contortions, is now glad to receive its power from the rival which has so far outstripped it—happy that it has not itself been crowded out of existence.

SANITARY PRINCIPLES IN THE CONSTRUCTION OF ISOLATION HOSPITALS.

By G. A. T. Middleton.

THE increasing attention which has been paid, during the last few years, to the study of infectious diseases, and the certainty of control which, it is found, can be secured by careful observance of sound sanitary principles in the design and equipment of suitable buildings for the treatment of patients suffering therefrom, has resulted, in England, in the erection of a large number of special hospitals for infectious cases. To these hospitals, which are maintained out of the rates, all patients suffering from certain complaints—notably scarlet fever and diphtheria—are compelled to be removed, unless the medical officer of the district is satisfied that thoroughly-efficient precautions are being taken against the spread of infection. Indeed, many people who can well afford all that is necessary to effect this assurance prefer, if cases break out in their homes, that the sufferers should be removed, so high is the reputation which these special hospitals deservedly enjoy. This is largely due to the perfection of the structural arrangements, giving each patient the greatest possible chance of recovery, while reducing the risk of contagion to a minimum,—a risk always present in a private house containing a case of infectious fever, however great the care taken.

To a great extent all hospitals are now planned upon well-understood principles; these are accentuated, with the introduction of but few new features, in hospitals for special cases. The pavilion system is universally adopted. There is usually a central block, forming, or near to, the main entrance, for administrative purposes, and containing the rooms for matron and medical officer and the kitchens; from this block range corridors, or open footways, to the various wards. As a rule, especially in hospitals of more than one story in height, the corridors, though open at the sides, are covered and placed one above another at the level of the various floors; in many general hospitals their sides are glazed, in addition, and sliding windows are provided, which can be opened at will. Where infectious disease has to be combated, however, the sides are preferably left open, so that free current of air may pass in all weathers, while, if the building be of one story only, even the roof should be omitted, as in Mr. Bishop's small hospital at Linslade. In large hospitals, like the Park Hospital (designed by Mr. E. T. Hall), a subway for the conveyance of pipes,

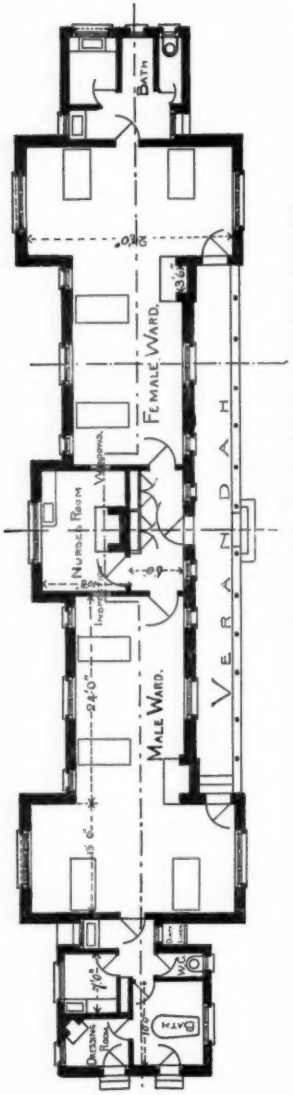
electric wires, etc., well lighted and accessible at all points for the execution of repairs, is placed under the corridor. The two buildings just cited may be considered typical modern hospitals, one upon the smallest, and the other upon the largest, scale,—both from successful designs in recent competitions, and only now nearing completion.

The wards are almost always arranged in separate blocks with their axes as nearly north and south as possible, so that sunlight may enter at all hours of the day, and with sanitary annex at one end, detached from the ward by means of a short corridor with open window on both sides; the nurses' inspection room is at the other end. Wards are generally 12 ft. high in the clear, about 22 ft. wide for a double row of beds or 13 ft. for a single row, a minimum of 2,000 cu. ft. of air-space being provided for each fever patient. Beds are never placed in the corners of the wards, spaces for the use of doc-

CORRIDOR
CORRIDOR
CORRIDOR
CORRIDOR
CORRIDOR
NEEDLE ROOM
KITCHEN
ASSISTANT NURSES
RECEIVING AND WEIGHING RM
PASSAGE
YARD
STORES
CLERK'S OFFICE
STEWARD'S OFFICE
SAMPLE ROOM
PASSAGE
COURT
COURT
COURT

THE PARK HOSPITAL. BLOCK PLAN.

tors and nurses being left on each side; in fact, the corners at the southern ends are often canted and a window inserted, to admit direct sunlight at mid-day; or, more rarely and only in small hospitals, Mr. Bishop's expedient of the T-shaped ward is used for the same purpose. Windows are arranged between the beds and opposite one another; they reach up to the ceiling, and have the upper portion hung upon hinges to swing open between hopper side-guards. In this way no draught descends, and the hopper lights may be open in almost all weathers; as a matter of fact, they are much more depended upon to provide ventilation than any elaborately-designed



SCARLET-FEVER BLOCK, LINSLADE RURAL DISTRICT HOSPITAL FOR INFECTIOUS DISEASES.

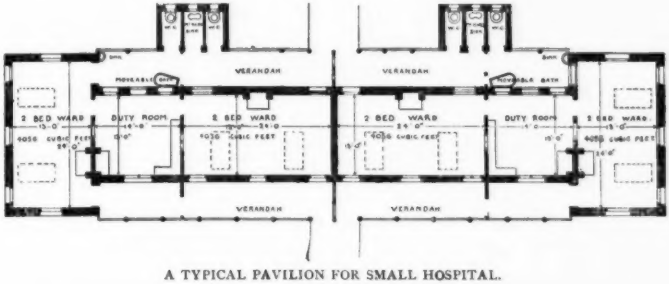
system. In warm and dry weather the lower portions of the windows can also be opened, either as sashes or casements, and, the openings being opposite one another, a perfect through current is obtained. In small hospitals it is usual to form the windows on one side of the ward, as French casements, opening down to the ground and giving access to a verandah, roofed at the level of the transom below the hopper-light. This verandah is enjoyed by convalescing patients in fair weather, and can also be used for the purpose of giving bed linen and bedding a "sun-bath" occasionally. In large hospitals of more than one story this verandah is often arranged in the form of a balcony at the end of the ward.

In such a hospital, containing more than ten beds to the ward (twenty being the maximum number), there are frequently two sanitary annexes to each ward, entered diagonally, one being used for baths and the other for closets; the balcony just mentioned is then placed between the two unconnected corridors, which are themselves constructed as tunnels, with free air passage above and below.

In the sanitary annexes are placed closets (of the wash-down type, as a rule, with lifting seat), a deep sink for washing bed-pans, and a bath; each of these occupies a separate well-lighted compartment, and all, as in the ward, are so designed that a duster can reach every part readily. The bath is on rubber wheels, and, after being filled, can

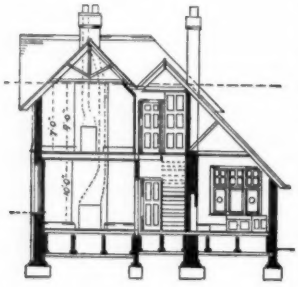
be wheeled to a patient's bedside, used, and wheeled back again to discharge over a trapped gully in the floor, discharging again to another similar gully in the open air. Of course, the drainage system must be perfect.

Two apparently minor, but really most important, points for the architect to bear in mind are, first, that floor, wall, and ceiling surfaces must be impervious and easily cleanable, and, second, that there must be no places where dust can accumulate. To mention the former is enough to secure attention to it; but the latter necessitates that there shall be no flat ledges or sharp re-entering angles anywhere, the junctions between floor and wall, and between wall and ceiling, and the corners of the room, all having to be rounded. Doors must be made without panels, fitting into circular rebates in the frames; key holes must be omitted, and all woodwork specially sectioned. There must be no spot, in fact, where a duster cannot get with ease.



A TYPICAL PAVILION FOR SMALL HOSPITAL.

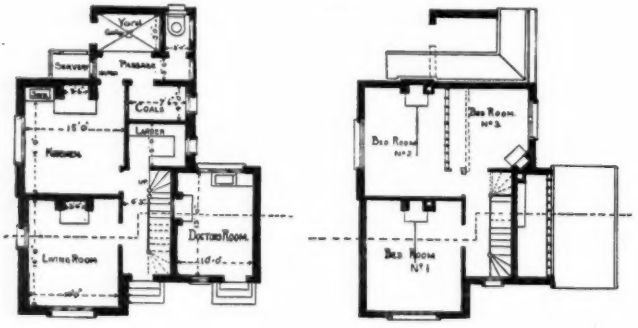
Artificial ventilation, although, for the reason already stated, it is a comparatively minor matter, is always carefully attended to, with particular reference to its employment in inclement weather, when the windows can be only partially opened, or upon the very rare occasions when they have to be completely closed. In large institutions the fan system of injecting warmed fresh air is occasionally adopted; more frequently a simple arrangement of inlets and outlets is thought to suffice, the fresh air being admitted through tubes in the floor and warmed by passing round a fire, of the open English type, but specially constructed, either in the middle of the ward, or, in small wards, in one of the side walls, before being allowed to enter at about 7 ft. from the floor. A small inlet, usually admitting air at the normal temperature, is commonly inserted under each bed also, while the outlets are invariably at the ceiling level, either into upcast shafts (supplied with some patent exhaust or heated, to create a current, by



SECTION

means of a gas jet), or else into a supplemental chimney flue. It will be understood that the open fireplace is also trusted to act as a sufficient low-level exhaust.

For small wards in small hospitals the open fire is generally the only means of heating adopted, in spite of its admitted imperfections —among these the noise of replenishing the fuel being by no means the least; but, where the facilities and the means at command allow, steam, hot water, or hot air is preferred.



GROUND FLOOR PLAN. FIRST FLOOR PLAN.

LODGE, LINSLADE RURAL DISTRICT HOSPITAL.

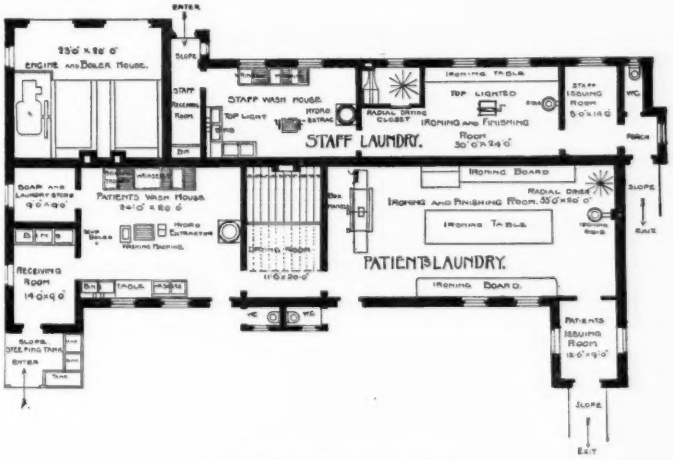
Similarly with lighting; though electricity is preferred, it is not always obtainable, and incandescent gas lights have then to be used instead. A light is, in either case, placed over the head of each bed, so located as not to irritate the patient and yet to give the nurse or doctor a good view of his features.

In the nurses' room, which always has a communicating window overlooking the ward, a fire is always kept burning, so that foods can be warmed or poultices made at any time. In connection with this room it is also convenient to have a store for clean linen, and a well-ventilated milk store; while a separate ward scullery is essential, as plates, cups, knives, etc., used by the patients in a ward, are never

allowed to travel away from it, but are washed in the ward scullery at once, and stored there in racks.

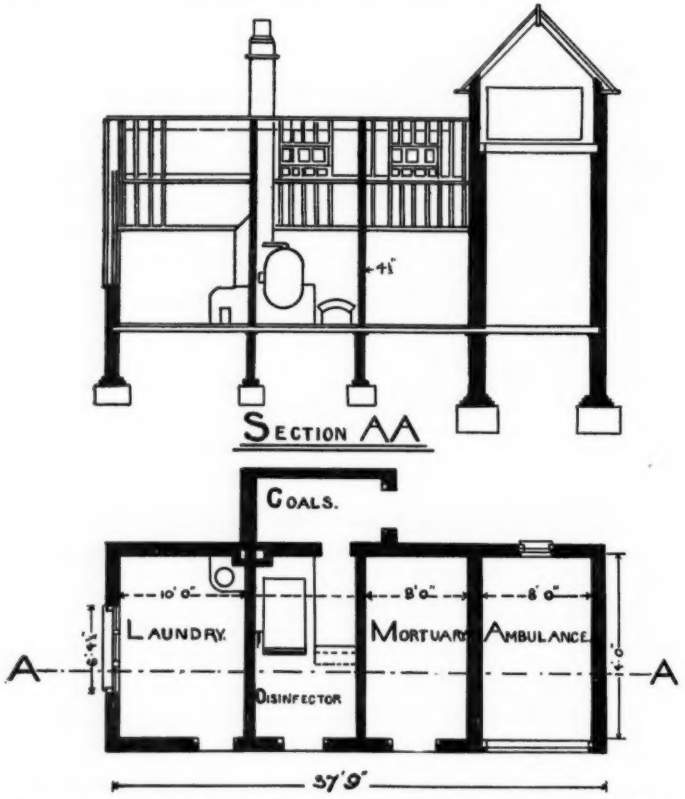
The food, it may be mentioned, after being cooked, is passed from the kitchen through a hatch to a freely-ventilated, but covered, serving pantry, and is taken thence by the ward nurse (who never enters the kitchen or comes into personal contact with the kitchen attendants) to her room, where it is cut for distribution to the patients.

Another important adjunct to the ward is the shoot, or bin, for soiled linen, through which it is thrown at once into the open air, after use, and taken away at regular intervals to the wash-house and disinfecting chamber; of course, in a large hospital, the laundry arrangements are perfect, and are distinct for infected and non-infected clothing.



LAUNDRY FOR LARGE HOSPITAL.

Special bath rooms, with dressing rooms, are provided for the daily use of the nurses, and for the discharge of cured patients. When nurses arrive, they enter the dressing rooms and change *all* their clothing, putting on clean things throughout and leaving their non-duty clothes. When they leave, after their spell of duty, they enter the medicated bath, leave their duty clothes in the bath room to be taken away and disinfected, and pass into the dressing room, preferably across a ventilated corridor, to put on their ordinary clothes. A precisely similar process is gone through with each patient just previous to discharge; provision for this must, of course, be made in the plan. In small hospitals the same bath and dressing rooms are used



LAUNDRY BLOCK, LINSLADE RURAL DISTRICT HOSPITAL FOR INFECTIOUS DISEASES.

for nurses and for discharged patients; in large ones separate accommodation is provided. The mortuary and doctors' rooms differ in no essential from those of an ordinary hospital, with the exception that no operating room is needed, and that absolute air disconnection between one part of the hospital and another is more imperative where infection has to be combated. Put shortly, the great modern cure for, and preventive of, infectious diseases, is fresh air—and plenty of it. To secure this without draught, to cut off by its means all that may possibly be infected from that which is healthy, is the architect's province.

The plans of the Park hospital are by Mr. E. T. Hall, those of the Linslade hospital by Mr. T. H. Bishop, and the typical laundry, pavilion, and administration block are from designs by Mr. W. A. Pite.

REVIEW OF THE ENGINEERING PRESS

The Launching of the Albert Bridge.

THE *Engineering Record* describes a novel method of erecting a long-span bridge at a point where false-work was impracticable.

The Albert Bridge is a structure on the Southern & Western Railway, and crosses the Brisbane river, in Queensland, Australia. It was originally built in 1875–76, but was washed out in 1893 by an extremely high flood, which overthrew all but two of the spans and the piers which supported them. Reconstruction was immediately begun upon a plan considerably different from the first one.

The new bridge consists of two double-track spans, each 340 feet long, which rest upon abutments and a central pier, all of masonry. The gage of the track is 3 feet 6 inches. The trusses are of heavy construction, with segmental upper chords, 41 feet 6 inches deep at the center panel, 21 feet 6 inches deep at the end-posts, and with a lateral dimension of approximately 50 feet over all. The bottom chord is 49 feet above ordinary high water, and 7 feet above the level of the flood which destroyed the first bridge.

We are forced to omit a description of the foundations, masonry, and details of the superstructure, all of which are extensively mentioned in the article from which we borrow.

Since the Brisbane river is a tide-water stream, it was possible to make use of this fact in the launching program, and the erection of the north span was therefore completed on shore, in a position which made its long axis coincide with the production of a line joining the centers of the pier and the abutment. The south span was erected on the two old trusses which remained in place and were used as false-work. "Ways" of heavy framed timbers, resting upon a carefully-levelled ballasting of gravel, were first constructed for the reception of the north span, which, during erection, projected 124 feet beyond the abutment over the river-side, and was supported for this distance by staging. Before the launching, the out-shore end was prepared to support itself as a cantilever for about 60 feet by means of temporary ties and compression members. When the time came for launching, the staging under this 60 feet was removed, and a large barge 45 feet wide, bearing a trestle for the purpose of receiving the bottom chord, was put in its place. There then remained a projection of 15 feet, which gave room for the end of the span to reach its seat on the pier in the middle of the river. The in-shore end was built upon a truck formed of heavy timbers, which were mounted upon four pairs of cast-iron wheels provided with 6-inch steel axles.

The process of launching was a simple one. At low water a barge of 800 tons' burden was floated under the out-shore end of the span, and in due time the flood-tide raised it into contact with the bottom chords. So little power was required to do the work that a 10-ton hand-winch, fastened to the deck of the old bridge and connected with the new span by cables, was sufficient to haul the barge and its load to the final resting-place in an hour and twenty minutes. Since the distance traveled was 225 feet, a comparatively rapid progress is shown to have been made. There was practically no chance of trouble, for the barge was moored in four directions, and during its movement the variation from the true line was but a few inches at most. Sighting-poles on the bridge, and 5-ton hand-winches, which were mounted on the barge, and to which the up- and down-stream mooring lines were attached, secured this result.

The floating into position of a completely-erected span is by no means a new idea, but the method by which the Albert Bridge was at the same time launched and towed is believed to be novel. Both at the Hawkesbury Bridge, in Australia

and the Ohio Connecting Railway Bridge, near Pittsburg, spans of great length, considerably longer than the Albert Bridge, were erected near the shore and towed to their resting places on the piers. And again, at Jacksonville, Fla., four spans of 250 feet each were treated in the same way; but in all of the precedents which we have named the erection was completed on trestles located on the margin of the river, from which place they were moved, wholly supported on one or more barges.

To the designers and erectors of the Hawkesbury Bridge, the Union Bridge Company of New York and Mr. Charles McDonald, its representative, the real credit for the general idea belongs. In this instance the spans were 415 feet long, and they were erected at a distance of about 3000 feet from the bridge-site. The bottom chord had an elevation of approximately 45 feet above the water. Piles were first driven near the river bank, and sawed off several feet below extreme low water; upon them barges were then sunk with open sea valves, which were not closed during the construction of the iron-work. A trestle was built upon the barges, and on this the superstructure was erected. When all was completed, the sea-valves were closed at extreme low water, and the rise of the tide floated the mass from its bearings. It was then towed into its final position; in one case this took but an hour and three-quarters. The erection of the Hawkesbury Bridge took place in 1888.

In 1889 Mr. C. L. Strobel, then chief engineer of the Keystone Bridge Company, adopted the same plan at Jacksonville. This is worth noting only because it appears to have been the first time that the plan was tried in this country (although it originated in the mind of an American engineer), and because his success encouraged Mr. Strobel to apply the method at the Ohio Connecting Bridge at Pittsburg in the following year.

The conditions at Pittsburg differed from those obtaining at the other three places in many important particulars, There was no tide, and mechanical means were therefore necessary for floating the structure; heavy floods were likely to occur at any time, and at only a few hours' notice; the span was unprecedentedly large, 523 feet long and of unusual height above the water,—about 75 feet. All of these considerations led those in charge of the work to depart widely from the methods previously adopted. As before, pile foundations were driven and their tops cut off, but above, not below, the water-line. On these piles, which were arranged in bent, heavy I-beams were laid, parallel with the long axis of the bridge; the I-beams supported the trestle on which the span was erected, in the usual manner. Just before the time of floating, coal barges of ordinary construction were placed under the trestle and between the pile bents. The barges were then pumped out, taking the weight of the trestle and span by means of the I-beams. They were then towed into the stream, swung around parallel with the line of piers, and, after reaching the proper position, lowered into place by flooding the barges, which were afterward sold to carry coal down the river.

In view of the perfect success attending each of these operations, it is somewhat surprising that more extended use has not been made of the general idea, which must be better in many cases than the fixed-trestle plan.

Electrically-operated Turntables.

AN interesting application of electric motive-power, which seems to be comparatively new and of some promise, is touched upon by *Engineering News* in its description of a motor of special manufacture for operating a locomotive turntable. This particular device, called by the builders an "electric donkey," is of 10 h. p. and weighs 3,700 pounds. The power necessary to turn the table, carrying a 100-ton engine, is stated to be ½ h. p. per hour, and is applied through a single traction-wheel running on a circular pit-rail. An earlier issue of the same journal contained a description of a similar contrivance installed by the Chicago, Milwaukee & St. Paul railway, and other installations

of like character, often of home manufacture, have been made by other roads.

One is just going into operation in the Erie railroad yards, at Jersey City, and it seems to be a useful and readily-practicable substitute for cruder and less convenient power-applications in many railway yards. No information is given concerning the connections by which the current is carried to the motor, but this is not a point presenting any difficulty.

The motor illustrated is apparently independent of the turntable, and moves it by simply pushing against the end.

Electrical Consolidations.

THE consolidations which have taken place between electric companies in the past are overshadowed by that which became of public knowledge in September. The absorption of the Walker Company by the Westinghouse Electric and Manufacturing Company was one of those announcements which, although coming as a surprise, are not surprising, because of their perfect reasonableness. A healthy amount of competition is as necessary in the electric field as it is in any other, and, conversely, too active competition is as damaging both to the manufacturer and to the purchaser.

In this case a new company (new as an electric company) entered a department of the industrial world which was already filled to overflowing, and brought with it little in the way of new equipment or ideas; but it had a consistent desire to do business. As a necessary preliminary, prices were cut on most staple articles, and, as a necessary result, the market was turned upside-down for a while. But the amount of business to be done was not increased, while the selling expenses of the older companies became heavier, almost in proportion to the added violence of the competition. This did, and always will, work in the following way: More competition, more agents; more agents, less profit; less profit, less progress.

It is as clear as an algebraic equation, and, like an algebraic equation of many quantities, may be solved in two or more ways; but, whether it is reduced to its simplest form by elimination (as in the present instance) or by some other method, the answer will always be the same, if the values of the elements are properly construed.

The public is probably more vitally interested in the prosperity of its great electrical companies than in almost any other line of industrial activity. Not because the rights of stock-holders,—although even that is of no small importance, now that the investor is allowed to hold up his head,—but because it is through the electric companies themselves and the efforts of their servants that we must look for advances in their great field.

When the discouraging failures, the costly experiments, and the splendid successes are duly regarded, there is no longer a question as to where the public advantage rests. The purchaser of an electric motor buys not only a device for converting energy into work; he also buys the material embodiment of the thoughts, the brains, the labor, of hundreds of brilliant and devoted minds. And have these things no pecuniary value? We think they have. But we may safely leave the moral side of the question to take care of itself, for it will surely come to its own in time.

Inventors and investigators in pure science are increasingly allying themselves with those aggregations of capital called companies, where they are protected from the scramble of the daily bread-winner and are encouraged to follow each his natural bent, without anxiety as to the present or the future. Under these circumstances they are frequently enriched by the same efforts which, if applied independently and without other support than their own means, would have resulted in actual starvation. But this is only a small portion of the expense which a progressive company must meet. Discarded devices which are obsolete before they are ready for the market, and others which are out of date before their sale can be made a source of profit; material and labor which are consumed in experiments, and in attempts to improve existing machinery,—all of these go to make up an immense annual

charge, a charge which works directly for the benefit of the public, and which must be currently met. If the public is to enjoy the advantages which accrue through this state of affairs, they must expect to pay for them, and they cannot be paid for except by generous treatment. The sort of buying which is right and proper when railway cross-ties or paving-blocks are to be purchased would be ruinous if applied to most classes of built-up electric material.

It is startling to look back twenty-five years and note the progress which has taken place in shop-practice, in the multifarious details of our acts and the things which attend upon our bodily comfort, a large part of them brought about by the men who have spent their brains or money in electrical research. If, then, so much has been accomplished in so short a time, what limit can be placed upon the future under favorable conditions? The things which have been done are as nothing to what may reasonably be expected, if the Teslas, the Kelvins, the Crookes, the Röntgens, and their co-laborers are generously encouraged.

Water Meters in Municipal Supply.

ONE of the most serious problems to be contended with in municipal engineering is that of water supply, involving as it usually does either costly aqueduct construction or extensive pumping plants; and when in addition to the expense of transportation the water must also be freed from impurities, the magnitude of the task for a great city becomes apparent.

When to the supply of water really needed for daily use there has to be added a large percentage for waste it is not to be wondered that water-works engineers are beginning to demand that some bounds shall be set upon the demands of a careless public and that some reasonable control of the quantity of water supplied shall be maintained.

Apparently all attempts to cause people to refrain from wasting water are unavailing unless some mechanical check is imposed, and the only recourse is the introduction of meters.

There has always been a great opposition to the use of any system of charging for water by measure, the general impression being that the consequence would be such a miserly use of water as to interfere with personal cleanliness among certain classes of inhabitants, a liberal use of water being rightly regarded as one of the most efficient preventives of disease. This, and several other misconceptions are well met in a paper recently presented to the Engineers' Club of Philadelphia by Mr. John C. Trautwine, Jr., the Chief of the Bureau of Water of that city, in which the popular errors about water meters are discussed and shown to be wholly unfounded in fact.

The volume of water supplied in Philadelphia is more than twice as much as there is any reasonable necessity for pumping, it having now reached the absurdly extravagant quantity of over 200 gallons per day for every man, woman, and child in the city, and yet there are numerous well-founded complaints from many quarters of insufficient supply and low pressure. "The reason is not far to seek. It is perfectly well-known that more than one-half of all the water pumped is wasted, flowing off into the sewers without benefiting either those who waste it—or the sewers." This waste is of various kinds, much of it being due to the leakage of imperfect faucets and other appliances, but a large amount of it passes through outlets which are permitted to run continuously when the water is only occasionally required, and such wastes, while made by only a small portion of the community, are now charged to, and paid for by all. Thus in one district in which a house to house examination was made, in 142 houses 22 appliances were found leaking slightly, and 32 were running steadily, the average consumption being 222 gallons per head per day, of which but 30 gallons were used and 192 gallons wasted.

In proposing to stop this state of affairs by the introduction of meters Mr. Trautwine recommends that the meters be applied, not to all dwellings, but only to those where outrageous waste is found to be going on, while the temptation to ex-

cessive economy can be prevented by the introduction of a system of minimum charge; this charge being so proportioned that the consumer will have drawn all the water he can possibly use and enjoy, together with a fair amount of waste besides, long before the meter reading has reached this minimum charge.

Much of the objection to the use of meters would disappear if the general consumer could be brought to realize that he is now paying for other people's wastage. It is a difficult thing for a man to grasp the extent to which water can leak through a comparatively small opening. An actual measurement of a slight trickling leak in a bath-room faucet showed an escape amounting to nearly 70 gallons per day, and yet many such leaks, which would be promptly repaired if meters were in use, are permitted to continue dribbling day after day for twenty-fours hours a day, simply because it is too much trouble to put in a new washer. With proper regulation of waste much of the money now required for the pumpage of an absurdly large supply could be used for filtration and improved distribution and the gain to the community would be beyond computation.

In comparison with the extravagantly large supply of over 200 gallons per head per day which Philadelphia has reached under the present system of waste, it may be of interest to note some figures of leading cities in England.

In Liverpool, for the supply of which the great Vyrnwy dam was built, the present supply is 25 gallons, and the maximum future supply for which provision has been made, 77 gallons per head per day; for Manchester the Thirlmere works now supply 20 gallons per head per day with an ultimate capacity of 100 gallons; while for Birmingham the new works now under construction to bring water from central Wales are to give an immediate supply of 57 gallons, and an ultimate one of 157 gallons, it being assumed in all three cases that the population remains stationary.

Mr. Trautwine concludes his paper with a number of reports from cities which have introduced meters, and in all of these the original opposition has vanished, while the wastage is stopped and the pressure increased, users finding that the care which the measurement of water compels them to keep over the leaks and other sources of waste, is trifling compared with the advantages gained.

In regard to hardship to manufacturers the low price, about one cent per ton, can hardly be considered a hardship, but if it is thought desirable to offer cheap water supply as an inducement to manufacturers this can be done as well with as without meters, since the meter does not fix the rate but only substitutes the payment by volume for the payment by time.

A New Movement in British Ship-Building.

UNDER the heading "An Ineffective Boycott" the *American Machinist* chronicles an incident which may have a wider significance than that which would attach merely to another failure of a generally discredited method of industrial warfare. It refers to the "proposed boycott of Harland & Wolff, the shipbuilders, of Belfast, because they refused to lock out their men, with whom their relations were entirely satisfactory, during the fight of last year. It was proposed to refuse to sell to them any shipbuilding material, evidently with the idea that, if British plate-makers, etc., refused to sell them material, they would have to go out of business. It does not seem to have worked that way, however. Last May a consignment of the largest size of ship plates were shipped from Pittsburg to Harland & Wolff, and it is stated that at least 800 tons more in plates 28×5 feet are being made by the same Pittsburg firm for the same destination. American pig iron is also being shipped there, and both plates and iron are laid down in Belfast at lower prices than they can be obtained from the manufacturers in the west of Scotland, who have previously supplied the demand."

A Spanish proverb refers to certain homely occupations in which "the beginning is everything." The principle often applies to the distribution of trade. A movement which appears to have in its

favor the arguments of economy and expediency is delayed until it is forced by necessity, but, once originated under this pressure, the realized satisfaction of the new experience and the acquired inertia of the new movement combine to oppose and make doubly difficult the reversion to the original status.

It would be rather strange if the tactics resorted to by the British masters in a struggle to put themselves abreast of outside competition should actually result in advancing their rivals. But competition is the begetter of improvement, and the incident will spur the British iron- and steel-maker to fresh enterprise.

Asphalt as a Municipal Improver.

THE press of September announced a meeting of the National Road Parliament at Omaha on October 8 in the grounds of Trans-Mississippi Exposition. From this meeting there should arise a movement of gigantic proportions, and full of promise for the good of the United States at large.

To one who has spent the last thirty years in a series of movings from one to another of the large cities north of the Ohio river and east of the Mississippi river, who has lived in seven of them for periods ranging from one to eight years, and who has visited nearly all of them at frequent intervals, there is given a basis for comparisons which is interesting historically and instructive as indicating the probable line of development.

A stay in Chicago which began in the spring of 1866 was suddenly and unexpectedly terminated on October 9, 1871, by the great fire,—a residence which was never renewed, though the city continued to be a sort of second home for many years. During the five years of actual residence the population increased and the city enlarged its boundaries, but there were no external signs of improvement. Pine boards formed the almost universal side-walk, and for pavements (where there were any) pine blocks laid on rough boards were made to serve. It was at this time that the grade of the city was raised twelve feet, and, except for a few main streets, the foot-ways were on trestles which were interrupted at every intersection with a flight of stairs on each side of the roadway. This, it can be seen, did not add to the beauty of the city, and the awkwardness was increased by the heterogeneous character of the buildings, which were of all materials, but mostly of wood, and of no style of architecture; quite a moiety were several feet below the level of the street.

Lincoln park had but just been begun, and for half a mile north of what is now the entrance it was an abandoned waste,—a favorite hunting-ground for boys and men who were satisfied to shoot sandpipers. The Calumet marshes, too, which are now the site of Pullman and South Chicago, were the haunts of many sorts of game, even including deer, at least as late as 1875. In very truth, there was excuse for the prophesy, seriously made, of a Bostonian who shared in the hegira on the day of the fire, to the effect that "in twenty years Chicago would be a wilderness, and the wolves would be howling through what had once been her streets."

Cleveland was the next stopping-place, and here the conditions were somewhat better, for the place was older; but even in that city, which was able to boast of its old families, there was no pavement worthy of the name in 1872, nor was there for many years after.

Pittsburg, Buffalo, Detroit, Rochester, and Toledo gave the same evidences of public indifference to appearances, although some were better than others. But the pavements were universally bad, the architecture was beneath contempt, and not more than a half-dozen really handsome houses were to be found in the whole list.

It would be interesting to know exactly what force has brought about so great a change in American cities. It has not taken place greatly in the smaller towns, and it therefore seems likely that the cities contain some element not often to be found outside of them. An increase in wealth will not account for it, since there has been no such increase *per capita* as is at all commensurate with the improvements which have taken place; for that matter, wealth alone could not bring it

about. It must first have been desired, and the real question is what created the desire.

To ascribe the change to a cause, at first sight, so remote as asphaltum pavements may perhaps strike the reader as ridiculous; but let us consider. A badly-paved street cannot be made to look clean and remain so, except at a considerable and constant expense; and, unless a street looks clean, it will not look well. The very hopelessness of the task caused it to be neglected. But, with the modern well-constructed asphaltum pavement, a highway came into being which could be cleaned at a reasonable cost, and therefore was cleaned. The first of these pavements in any city must have had its powerful and individual effect on those who saw it, and consequently on its neighborhood.

In all of the cities mentioned there was the same awakening, closely following the introduction of permanently smooth pavements,—an awakening which soon possessed the whole body, and grew in strength as the possibility of satisfying the demand became more evident. Then came the inevitable. Mr. A. repaired his fence and bought a lawn-mower; Mr. B. not only did that, but painted his house too; Mr. C. painted his house, and added a bay-window; each, not satisfied with emulating, but striving to surpass, his neighbors, until at last Mr. D. and the rest of the alphabet rebuilt entirely, on plans provided by an architect,—for the contractor and builder could no longer rise to the occasion.

It is not intended by this argument to show that there have been no other causes at work towards this end; but, in view of what has happened in so short a time, the conclusion is unavoidable that smooth pavements have been a principal reason for the change, the magnitude of which could not have existed and continued without them as a governing factor. In each of these cities the general improvement followed and did not lead the construction of good streets, and the statement is probably true of the other cities in America.

Incorrect Indicator Practice.

A CORESPONDENT of the *American Machinist*, in a recent issue of that journal, calls attention to the error of assuming that the closed cycle obtained from one end of the cylinder truly represents the action of the steam as it should be conceived and studied, and maintains that the forward stroke on one end of the cylinder should be considered in connection with the exhaust action going on at the same time on the opposite side of the piston.

The whole subject is well worthy of study in the manner in which the *American Machinist* has presented it, and undoubtedly forms an argument in favor of continuous indicator diagrams. It is hardly correct, however, to consider that this view of the subject is now presented for the first time, or that the ordinary manner of considering the indicator diagram is a "universally" incorrect way. More than twenty years ago the well-known German engineer, Herr Paul Kauffer, only recently deceased, called attention in the pages of *Dingler's Polytechnische Journal*, to the facts now published in the *American Machinist* and a translation of his paper appeared in the *Journal of the Franklin Institute* for July, 1877.

As Kauffer put it in 1877, "every diagram consists of a curve of work and a curve of resistance, and these two curves are not traced at the same time; but, for example, the curve of work is taken in the passage from left to right, and the curve of resistance in the return from right to left. In order to indicate a working cylinder, I use, wherever it is possible, an indicator on each end of the cylinder, and it was the analysis of just such a case that first showed me the necessity of making the correction." This was followed by indicator diagrams almost identical with those in the *American Machinist*.

The *Machinist* therefore scarcely can maintain that the less correct practice has gone "entirely unchallenged," although it is not undesirable to have attention again called to the fact that some users of the indicator do not take the resistances into account in the order in which they actually occur.

The Metric Propaganda.

IT would be difficult to select for discussion an abstract subject of more importance at the present time than is the metric system, and it would be equally difficult to have it more rationally or concisely presented than is done by Mr. Edward Grafstrom in the *American Engineer*. He appears to be well acquainted with the efforts which have been made to introduce its use in the United States, and does not wholly approve of them. That is, he believes too much reliance has been placed upon the ability of congress, by making laws, to cause the adoption of the system by the people at large, and that this concentration of purpose has interfered with directing the movement into other and more promising channels. He goes further than this, however, by stating that congress has apparently done nearly all that is in its power already, by passing laws legalizing the use of the meter.

The main point to be considered is: how is the work to go on? And in this Mr. Grafstrom's experience is of value. He tells us that he lived successively in two countries during the transition from the old plan to that of the metric system. In one of these countries the time allowed for the change was eight years; in the other, ten years; and the methods employed by the respective governments were practically the same. In all of the schools (which were under full government control) the metric system was taught before the children were instructed in the complications of the prevailing tables, which they consequently approached with a substantial prejudice. This was the first step. Following it came the addition of metrical distances to mileposts and station and other railway signs. New foot-rules, scales, and balances were graduated on both systems; applicants for positions in the civil service were examined in the use of the new system, and private employers soon began to require the same knowledge.

To show a familiarity with them, and to ask in the shops for a meter of silk, a kilogram of coffee, or a liter of beer, soon became a fad, until at the end of the fourth year the public found themselves to all intents and purposes, on a meter basis. And this was done without a single compulsory step to inconvenience them. At the same time, the manufacturing industries had been quietly, but steadily, preparing for the change.

The ruling power had decided that the metric system was the best, and it was then necessary only to fix upon the least troublesome way of bringing it into use,—a comparatively simple proposition. But in America the initiative which makes any such course possible is lacking and conditions favorable to such a plan are not likely to occur; so the problem must be solved in a totally different way. Mr. Grafstrom thinks that it can and must be done through a gradual education of the voting masses, leading up to a demand for the change on their part.

This seems a hopeless plan, and would certainly abort unless there were some stronger force back of it than is now apparent. For many years the various scientific societies have proposed, discussed, and resolved upon the adoption of the metric system in the United States; sometimes with a bare majority in favor, often with a large majority against concerted action, but never with that enthusiasm which is essential if an argument is to convince or a position is to be maintained.

That which appears to be most needed, therefore, in order that their dormant interest and energy shall be aroused, is a martyr, and to be a martyr one must first be an enthusiast. Prof. Mendenhall and a very few others with him have done splendid work; they have been the authors and movers of practically all that has been accomplished so far. But the martyr, the enthusiast, the bore who will talk his subject in season and out of season, who will ride his hobby through the halls of the technical societies, that man (or those men, for, the more they are, the sooner will the struggle be over) has not yet arisen; but he is sure to appear sooner or later, and, when he comes, he will beget others. Then the end will be in sight.

THE BRITISH PRESS

Ships of War in Action.

AMONG the many conflicting and contradictory accounts of the naval actions of the Spanish-American war it is refreshing to turn to a very clear and apparently impartial article in *The Engineer*, compiled with much labour from official and press reports and summarized with skill and judgment.

Commencing with the battle at Manila, and including the affair of the Winslow at Cardenas, the landings at Baiquiri and at Guantanamo, and the torpedo-boat manœuvring at Santiago, the study is completed by a consideration of the final engagement at Santiago and the destruction of the Spanish fleet, and the work done and the damage sustained by the various vessels are carefully analysed.

The net result of the two months' active naval warfare between the battle of Manila, on May 1, and the destruction of Cervera's fleet outside of Santiago, on July 3, points to a continuation of the policy of building sea-going battle-ships and armoured cruisers by all the ambitious naval powers of the world, the gun-fire on both sides having demonstrated that the ordinary plating of unarmoured ships offers no obstacle to the direct fire of common shell timed to burst in the interior of the vessel. No harm, however, was done at any time to the armoured sides of the American battle-ships, although they were struck several times by Spanish shot and shell.

Apart from the question of ships, there can be no doubt that the superior skill of the American sailors and gunners had much to do with the result. Not only was this shown in the matter of marksmanship, but also in the important work of extinguishing fires on the American vessels, such fires on the Spanish ships being permitted to get beyond control. The principal weak point developed by the American ships was their limited supply of ammunition, this especially having reached almost a critical stage during the battle at Manila.

This shortage of ammunition is partially attributed to the small ammunition-capacity of the earlier American vessels, but there is some reason to believe that it was also due to some extent to the fact that many projectiles had been expended in target practice, so that the superior precision of fire may have been attained at a cost which came near being embarrassing.

The analysis of the various engagements contains no direct opinion concerning the true value of torpedo boats and destroyers, the writer rather being contented with an account of the attempts which were made to use these as yet somewhat experimental engines of naval warfare. The attack by day on Admiral Dewey's fleet, by two Spanish torpedo boats, during the battle of Manila, resulted in the destruction of both boats before they could get within torpedo range; the night attack on the Texas at Santiago failed from the premature discovery by the enemy, combined with incompetent handling of the Spanish boats; and the destruction of the Furor and the Pluton by the Gloucester may properly be attributed largely to lack of practical experience on the part of the crews of the formidable destroyers. What would have been the record of this class of craft had they been manned by Anglo-Saxons can only be conjectured, but it is safe to warrant that torpedo boats and destroyers will continue to be added to the navies of all first-class powers until some more decisive proof of their inferiority is forthcoming.

Submarine mines did not prove effective in a single instance, although many of them had been laid down by the Spanish in the harbours of Manila and Santiago. The controlled mines at Manila were exploded prematurely,—an evidence of such inexperience as is shown by the amateur photographer, who almost invariably makes an instantaneous exposure too

soon, until he has learned to restrain his hand and use cool judgment instead of nervous excitement. The contact mines which were examined at Guantanamo were so clogged by marine incrustations as to be quite innocuous, and evidently much of the caution which was exercised in connection with submarine mines by the Americans was due to an over-estimate of the extent and character of these defenses.

The bombardments of Spanish fortifications by the American fleet did but little harm, except in the case of some of the older masonry structures, which were hardly expected to offer much resistance, and it was only in the destruction of some of the smaller forts along the coast that any really valuable work of this sort was done.

The analysis of the battle of Santiago, which practically terminated the war, is remarkably full and lucid. By using the reports of reliable press correspondents in connection with Admiral Sampson's official report, a continuous narrative is obtained, which is probably as near the true record as can be gathered from the numerous contradictory statements current immediately after the battle.

Without going into details, for which space is here lacking, the principal lessons to be gathered are the supreme importance of speed in battle-ships, the great desirability of powder which not only is smokeless, but produces no suffocating fumes, and the great danger from fire when much interior woodwork is used. The most effective work appeared to be that of the six- and eight-inch shells and the rapid-fire guns, and the manner in which the delicate range-finders and indicators were disabled by the shocks from the guns they were intended to serve should cause important modifications.

To quote the conclusion of the article: "It is plain that the Americans won by bravery, coolness, discipline, and drill. It is equally clear that the Spaniards were demoralised by the superiority of the Americans in rapidity and effectiveness of fire. The lesson seems to be that in future naval conflicts a superiority, however slight, in the beginning of an engagement becomes multiplied in its effect on an adversary by something like geometrical ratio, since the moral disorganisation produced by cutting off the return fire encourages accuracy of aim on the other side as fast as the ranges are found by actual trials. This, however, does not settle the question of whether many guns with light crews would be superior, other things being equal, to fewer guns with heavier crews, or with a competent reserve to take the place of men put out of action. Another most important deduction is that shooting in action with high-power guns by no means yet compares in accuracy with practice shooting."

It is interesting to note that in this excellent paper *The Engineer* definitely abandons its former attitude of favourable bias toward Spain, and takes a position, with practically all other publications of reputation, much more in accordance with the facts as now definitely ascertained.

The Designing and Construction of Refuse Destructors.

THE destruction of refuse by burning is now so fully accepted as desirable that the advisability of introducing suitable devices for the purpose is hardly longer a question. Rather is it important to consider the best form of destructor to be used, and it is this problem which is discussed in a paper read before the Dublin congress of the Royal Institute of Public Health by Mr. F. L. Watson, and published in *Engineering*.

In the first place, Mr. Watson emphasises the fact that complete destruction of refuse means an absolute chemical separation of the combustible portions (such as the carbon, phosphates, and nitrates, which are found in cinders and in animal and vegetable matter) from the non-combustible (which are chiefly mineral), and includes the complete oxidation of the former, and the fusion and agglomeration of the latter, so far as possible, into a hard clinker.

In order to accomplish these results, a high temperature, above all things, is necessary. This temperature should be not lower than 1,300° F., and had better attain

1,600° or even 1,800° F. In some forms of furnace the high temperature is reached only by the products of combustion in the flues, the gases coming off at a high heat; but the true principle of destruction requires that the heat should be great in the furnace itself, and should permeate the whole mass in the presence of sufficient air to oxidize everything oxidizable, ample time being allowed for the operation.

When this fundamental feature of high temperature in connection with proper supply of oxygen is accomplished, the resulting products are: a discharge of gases at a sufficiently high temperature to make them available for the generation of steam; a mass of hard clinker, or slag, which may be removed, crushed, and used with lime to form mortar; and a certain amount of dust, which should be removed in as cleanly a manner as possible.

When the temperature of the furnace is not as high as that indicated above, the destruction may be imperfect, and the resulting clinker, instead of being hard, is soft, friable, and frequently even putrescible; indeed, it is not uncommon for this imperfectly-burned clinker to take fire again after being removed.

The high temperature of the discharge gases renders them eminently adapted for the generation of steam, and in practice it is found that eight tons of refuse are about equal to one ton of coal for steam-raising purposes. In order to secure the best results, the boilers must be placed near enough to the combustion cells to prevent any important loss of heat by radiation, but they must not be placed near enough to interfere with the perfect combustion of the gases, which is generally not completed until after they have left the furnaces and traversed a certain length of flue to insure proper mixing. Even in the case of a boiler fired with coal any contact of the gases with the comparatively cool boiler surfaces will check the combustion and cause smoke, and it is obviously useless to mix oxygen with unburned gases after they have dropped below their temperature of combustion.

Since the principal expense incurred in the destruction of refuse is that for labour, it is an important matter to so design the furnace as to require a minimum of manual labour. This can be accomplished to a large degree in connection with the delivery of refuse and the charging of the cells, but so far mechanical stoking appliances have not given satisfaction, while they add greatly to the cost. Even in the case of an ordinary boiler furnace the exercise of considerable judgment is required to insure the best results, and with so variable a material as refuse it is necessary to use more care in cleaning than can be secured by any mechanical device.

The principal points to be borne in mind in the design of refuse destructors are: the production and maintenance of a high temperature in the furnaces; greatest facility for delivering and discharging the refuse at once into the cells; ample opportunity for the removal of clinker and dust; and, as an after consideration, a judiciously-arranged steam plant for the utilisation of the heat contained in the discharge gases.

Mr. Watson concludes his paper by the description of a number of existing plants, some of which have been remodeled from earlier forms, and others of which have been designed from the first in accordance with his views; and he gives much detailed information of value in connection with destructor-design.

Deliberate Train-Wrecking.

THE *Engineer* recounts four deliberate attempts at train-wrecking within a period of a few days and an area of fourteen miles. The first of them took place very shortly after the Wellingborough derailment (which, however, was not caused through malice prepense), and the four occurred, two near Northampton, one near Wellingborough, and the fourth at Oakley Junction, near Bedford. It is curious to note that the means employed in each case was an obstruction placed on or between the metals, instead of, as is common, a removal of some part of the track materials; in only two cases was any track material used.

In fact, in but one instance did the ob-

struction bear any evidence that it might have been put in position by a servant of the railway. This was at Wellingborough, and the attempt was made upon the same train which had suffered (by pure accident) the previous week. The arrangement consisted of two pairs of fish-plates, which were screwed together over each rail; across these two heavy iron bars were laid, and a third bar was partly embedded in the ballast, with its upper end so inclined as to pierce the fire-box of a locomotive passing over it. In the opinion of the *Engineer*, the escape of the train was almost miraculous, and is to be accounted for only by the high speed and the consequent force of the impact.

This is undoubtedly the reason of the escape of the train, but such escapes occur more often than they are generally supposed to by any except the railway officers who conduct the investigations, and should not be regarded as remarkable. The total immunity of the four trains on which these apparently well-conceived attempts were made is a sufficiently clear proof of this statement.

In America, where no regular train locomotive (as distinguished from those used for shunting) is ever sent out unprovided with a pilot (cow-catcher), efforts so bungling would scarcely be expected to cause a wreck. The writer has a vivid recollection of a ride on a locomotive through the State of New York one wild and stormy night, where he sat on the same box with, and just behind, the driver. The line was built on the banks of a large river; the cuts, very badly drained at best, were generally through a blue clay mixed with boulders, and each heavy rain made these last come tumbling down with alarming profusion. In consequence, the train on this night was frequently stopped by the watching-patrol, to await the removal from the track of small avalanches of clay and rocks.

These delays made the train lose time, and the driver took advantage of a comparatively open stretch of country to pick up his speed. On a piece of straight line about fifty yards in front the head-light exposed a boulder quite half-a-yard in diameter, lying partly on the rail and partly on the sleeper. There was no time to stop, hardly time to appreciate the situation, but the driver gave his engine more steam, and yelled: "See me knock it!" And knock it we did, without further damage than a bruise on the pilot.

Another conclusion of the *Engineer*, which seems to lack the confirmation of experience, is that the motive of the crimes was train-robbery. In the light thrown by something like a score of investigations of deliberate attempts to wreck trains on a certain line, there were not more than two, or perhaps three (we speak from memory), in which robbery was finally regarded as even the possible motive. Like the four mentioned by the *Engineer*, they almost always occurred in batches, within a short period of time and a restricted area. Three attempts were once made within a week, in a space of a mile near a certain large town, all of which took the form of disconnecting the points and setting them in the wrong position for through trains.

Fortunately no wreck occurred, and the criminal, who was soon caught, proved to be a lad of fourteen years, the son of an old and reliable servant of the company, a plate-layer. The lad was bright and intelligent, but was apparently possessed of an uncontrollable tendency; and in his confession, which was complete and circumstantial, he stated that he had heard of wrecks, but had never seen one and wanted to. He was prosecuted, not for train-wrecking, but for pilfering (of which he was also guilty) and the public, were kept ignorant of the facts so far as possible, for experience had shown that, the more widely such things are commented upon, the more certain it is that other attempts will be made.

From the fact that no apparent effort at robbery was ever detected on any of the occasions when a train came to grief, it was finally concluded that some other motive must usually be assigned, even where it was impossible to reach a definite determination. But this was seldom the case, for in almost every instance, sooner or later, the facts became known. A farmer whose land bordered the line had a grudge

against the company because of an unpaid claim. He therefore picked several stones from under the rail in the abutment of a small culvert, leaving one of the stringers practically unsupported. It was fortunately discovered in time to prevent what would otherwise have been a horrible destruction of human life, and it would have remained an unsolved mystery, if the scoundrel himself had not given the clue several months later, when in his cups.

On another occasion a discharged servant endeavored to balance accounts by removing some rail-fastenings, and in a well-remembered case an enemy had tried to injure a fellow-workman by dropping one of the latter's tools in the opening of a crossing point.

These and many other occurrences of a like character seems to demonstrate that most of the intentional wrecks are due to a degenerate mental condition, or to a criminal tendency on the part of those causing the wrecks, and that robbery is seldom the motive.

Wind Pressure.

THE address of Sir John Wolfe Barry before the Mechanical Science Section of the British Association, contains much matter of value, and among the numerous interesting subjects discussed we desire to note some points connected with the estimates of wind pressure upon framed and other structures. As long ago as 1840 Tredgold laid down the rule that provision should be made for possible wind pressures as high as 40 pounds per square foot, this figure having been obtained from measurements taken with a wind gauge. Following such an eminent authority, roofs and bridges, whenever any calculations for wind pressure were made, have generally been designed to resist a pressure of 40 pounds per square foot over the whole surface.

"Under the alarm caused by the fall of the Tay bridge in 1879, the piers of which were probably not strong enough to resist a horizontal pressure of one-fifth this amount, a further general assumption was made, and railway bridges throughout the kingdom were ordered by the Board of Trade in 1880, acting no doubt on expert advice, to be in future designed, and are designed to this day, to resist 56 pounds of horizontal wind pressure on the whole exposed area with the ordinary factors of safety for the materials employed, as if such horizontal strain were a working load."

It has been suspected, however, that tests upon small wind gauges do not give results which can properly be extended to large surfaces, and comparisons made at the Forth Bridge on two wind gauges of 300 square feet and 1½ square feet respectively, indicated that with an increase of area the unit of pressure fell off in a very marked degree. Under the same conditions of wind and exposure the larger gauge registered a pressure 38.7 per cent. less per square foot than the smaller gauge.

If this proportion holds good for all cases there has undoubtedly been a large excess of strength allowed in those modern structures in which the possible wind pressure of 56 pounds per square foot has been assumed as possible. Sir John himself states that experiments made at the Tower bridge have shown that the wind pressure on the bascules in certain instances, as measured by the power exerted by the actuating engines, was only 1 to 1½ pounds per square foot at a time when small anemometers registered 6 to 9 pounds, the area of the bascule under consideration being about 5000 square feet.

While it is very desirable that reliable data should be obtained for such an important element as wind pressure, it seems as if it would be unwise to accept a lower estimate than the existing one of 56 pounds per square foot until we are quite sure that the latter is too high.

Probably the best method we have at present for estimating the extreme force of wind pressure is that of the computation of the strength of structures which have been actually overthrown by it. At the time of the great tornado at St. Louis, in 1896, much damage was done by the wind, and in a paper subsequently presented before the American Society of

Civil Engineers Mr. J. Baier made some estimates which are of interest in this connection. In the case of some overturned bridge work he concluded that the lifting force of the wind could not have been less than 43 pounds per square foot, while in another instance the pressure on a surface 180 feet long by 18 feet high must have been at least 60 pounds per square foot. A chimney 162 feet high was broken in two at a point 40 feet from the ground, and taking the area upon which the wind acted as 14 by 110 feet this is estimated to have required a pressure of more than 80 pounds per square foot.

While such computations involve certain assumptions as to the resistance of the wrecked structures these are no more uncertain than the assumptions which must be made in the design of new structures, and while such tornadoes as that which occurred at St. Louis are rare yet their occurrence is within the bounds of possibility and should be provided for. It seems therefore hardly time to make any radical change in the estimate of wind pressure until some more certain information is available, although it is undoubtedly most desirable that all reliable data should be gathered and discussed.

Purification of Sewage by Bacteria.

AMONG the papers presented before the Bristol meeting of the British Association may be noticed that of Messrs. Dibdin and Thudichum upon the bacterial method of sewage purification. The work of Mr. Dibdin in this important field is so well-known that the latest expression of his opinions is of much interest, especially in view of the experience which has been had at Exeter, Sutton, and elsewhere.

This experience has shown that for the bacterial purification of sewage the following points must be considered: 1, Air supply or its absence in the case of the septic tank; 2, Temperature; 3, Admission or exclusion of light; 4, Reaction to test paper of the sewage to be purified; 5, Time of contact; 6, Nature of bed material; 7, Depth of bed.

"In the presence of a free air supply aerobic organisms are able to liquefy, break down, and oxidise solid organic matters without such decomposition being accompanied by any of the ordinary phenomena of putrefaction. Within two hours an effluent may be produced which may contain considerable quantities of nitric acid, and in which nitrification is afterwards continued at an extremely rapid rate."

For the aerobic process a free air supply is necessary, and an artificial air circulation may be employed, and even in the anaerobic process the air is not absolutely excluded from the septic tank, so that both processes really go on together.

In regard to temperature, it has been found that frost does not destroy the vitality of the organisms, the filter at Barking having continued to work although covered for six weeks with a sheet of ice.

The action progresses most favourably when the reaction to test paper shows a slight degree of alkalinity, but occasional variations in this respect appear to exert but little influence.

Time is a matter of importance, and it has been found necessary to subject the sewage to the action of microbes for a certain period, or the purification will be incomplete. If the proper time is greatly exceeded, however, the recuperation of the bed is affected. Two hours is found to be a satisfactory time for the sewage to be locked in the beds, the effluent being then allowed to escape, while the organic matter held in the bed is vigorously attacked by the organisms.

The bed may be made of coke, breeze, burnt ballast, broken slate, or the like, the depth being from 3 to 3½ feet.

In the general discussion of the bacterial processes of sewage purification there seems to be a general disposition to regard the subject with a certain degree of caution, the need of further definite practical information being undoubtedly felt. It is a question as to whether the anaerobic process is not always necessary as a precedent to the aerobic process, the formation of ammonia taking place first, during the two-hour resting period, and the nitrification following.

In connection with the proposed use of the processes on a large scale, the question of the varying character of the sewage must be taken into account, the changes in volume and composition, due to rain storms and other conditions rendering it impossible to insure uniformity. In order to determine the proper area to devote to a given quantity of sewage the London County Council proposes to institute a series of experiments on organisms for the purpose of finding out whether the methods which have given good results with small plants may be made available in dealing with 200 millions of gallons per day.

The Presidential Address of Sir Wm. Crookes.

THE meetings of the British Association always bring with them valuable and interesting papers on the branches of science dealt with by the various sections, but the especial feature of the recent meeting at Bristol was undoubtedly the presidential address of the incoming president, Sir William Crookes.

In this remarkable contribution to scientific thought and research so many subjects of fundamental importance were discussed that it is almost impossible to give even a meagre abstract of them, and naturally those dealing with the speaker's own special field of chemistry and physics were given especial prominence. In addition there were a number of topics of interest to the engineer which received attention, and the whole address forms a paper which should be read by all who are interested in modern scientific progress.

The main topic of the address, one which is only indirectly related to the work of the engineer, was the impending insufficiency of the wheat supply of the world. Natural resources being inadequate to meet the continual pressure of population upon subsistence, recourse must be had to the work of the chemist. "Before we are in the grip of actual dearth, the chemist will step in and postpone the day of famine to so distant a period that we, and our sons and grandsons, may legitimately live without undue solicitude for the future."

Passing on to matters in the domain of physics, the subject of radiography was taken up, and since it is due to the Crookes' tube that the work of Röntgen and his followers was possible, the subject could not have been in better hands. The principal feature brought out was the discovery that rays generated in "soft" tubes, or those having a moderate vacuum, have a less penetrating power than those emitted by "hard," or high-vacuum tubes. With a very high-vacuum tube Röntgen has photographed a double-barrelled rifle, showing not only the leaden balls within the steel barrels, but even the wads and the charges, while Dr. Rieder claims that the rays from "hard" tubes do kill bacteria, a question which, though often discussed, has not yet been positively settled.

The question of the property of certain substances of emitting rays similar to, if not identical with the Rontgen rays, without electrical excitation, was discussed by Sir William. Uranium and thorium compounds are of this character, and it may be that this is a general property of matter, since Dr. Russell has shown that nearly every substance is capable of affecting the photographic plate if exposed in darkness for a sufficient time. The investigations of M. and Mme. Curie have shown that there is a new constituent of pitchblende which possesses in a 400-fold degree the property of uranium of emitting a form of energy capable of impressing a photographic plate, without needing the excitation of light or the stimulus of electricity, apparently drawing from some exhaustless supply of energy. However much this idea may conflict with existing notions, there seems to be no doubt that there are many stores of energy in nature that may be drawn on by properly constituted bodies without very obvious cause.

Referring back to his own investigations into psychical phenomena, made many years ago, Sir William referred to the possible analogy between mental telepathy and space telegraphy, the action of the brain cells and nerves being marvellously like that of the particles in the Branly or Lodge coherer. However this may be, modern research seems to have brought

the phenomena of mental and physical activity closer and closer together. Referring to the famous remark of his predecessor, Dr. Tyndall, in his Belfast address, that he "discerned in matter the promise and potency of all terrestrial life," Sir William said that he preferred to reverse the apothegm and see "in life the promise and potency of every form of matter"!

The Thermal Efficiency of Steam Engines.

THE importance of a standard of efficiency for steam engines such as to make the performances of engines tested at various times and places comparable, has been realised for some time, and in order to further the establishment of such a standard the Institution of Civil Engineers some time ago appointed a committee to investigate and report upon the subject.

With Prof. A. B. W. Kennedy as chairman and with such experts as Mr. Bryan Donkin, Prof. Ewing, Mr. Macfarlane Gray, Capt. H. R. Sankey, and others as members, unusual interest attaches to the report which is now made public, and while it consists only of recommendations, there is little doubt that in some modified form perhaps, the report will form the basis for a method of conducting engine tests which it is hoped will become an international standard.

"There are two methods of stating the thermal economical value of a steam engine. In the first, which is principally used for scientific purposes, it is expressed as a ratio, and it is in this connection that a so-called standard of thermal efficiency is needed; in the second and more ordinary method, an absolute statement is used, such as pounds of feed water per indicated horse power, or heat units supplied per indicated horse-power per unit of time."

The term "thermal efficiency" has been applied to several different ratios, and it is desirable that any possibility of confusion on this account be prevented. The term has been applied to the ratio which the work done upon the piston bears to the heat supplied to the engine, and it has also been applied to the ratio of the performance of the engine to that of some ideal engine, or other less definite meanings have been given to it.

With the view of avoiding risk of misunderstanding in the future, and of obtaining the great advantage which would result from the adoption of a uniform system of nomenclature, the committee recommends the following definitions:—The expression "thermal efficiency" as applied to any heat engine should mean the ratio between the heat utilised by that engine and the heat supplied to it.

"In the case of any particular actual steam engine this ratio can be determined by calculations based on actual experiment in the following manner:—The heat units utilized as work are to be obtained by measuring the indicator diagrams of the engine in the usual way, to ascertain the mechanical work done. The heat supplied to the engine is to be calculated as the heat required to produce at constant pressure the steam that enters the engine, from water at the temperature of the engine exhaust. This rule applies whether the steam be saturated or superheated; also whether the engine be non-condensing or condensing."

When it is desired to compare the performance of an actual engine with that of some ideal engine the result is practically not an efficiency, but the ratio of two efficiencies, and for this reason the committee recommends that it be called the "efficiency ratio," thus avoiding a possible confusion of terms. For the ideal engine either the Rankine or the Carnot cycle may be employed, but the Rankine cycle is definitely recommended.

Incidentally attention is called in the report to the fact that the expression of the thermal economy of a steam engine in pounds of feed water per hour is inaccurate, since the number of heat units required to produce a pound of steam is not constant. With saturated steam the error is unimportant, but when superheating is employed the point becomes of consequence.

In order to facilitate comparison with an ideal engine on the Rankine cycle a diagram of curves showing the thermal units expended per minute per horse power is given, and entropy diagrams are also shown.

THE CONTINENTAL PRESS

The Briare Aqueduct and the French Canal System.

THE system of internal water-ways now existing in France provides for a very large traffic, which is constantly being increased by the improvements in canals and canalised rivers, one of the most recent pieces of engineering work in this line being the aqueduct over the Loire at Briare, a very full account of which is given in the *Annales des Ponts et Chaussées*, with numerous plates showing details, both of the aqueduct itself and of the lateral canal of the Loire of which it forms a part.

At the present time the waterways of France may be divided into four systems, which, with their approximate annual tonnage, are as follows:

Paris to Belgium, from 2,000,000 to 3,000,000 tons;

Paris to Havre, a minimum of 1,243,000 tons;

Paris eastward, by way of Reims, 600,000 to 800,000 tons;

Paris to Lyons, by way of the Bourbonnais, 400,000 to 600,000 tons on the canals of the Seine and Saone, and 565,000 tons by the lateral canal of the Loire.

The weak point of this last route has been the necessity of crossing the Loire at Chatillon-sur-Loire in order to make connection with the Briare canal on the right bank. This crossing involved locks on both sides of the river, the fluctuating level and especially the high floods causing much trouble and delay.

It was therefore decided to carry the canal across the river by means of an aqueduct, which necessarily involved a change in the canal level on both sides of the river, and practically a new construction of the canal for more than eight miles on the left bank, and a triple system of locks on the right bank. This reconstruction of the so-called lateral canal of the Loire was conducted before the aqueduct was built, the old canal and locks at Chatillon being used until the new water-way was opened.

The aqueduct over the Loire is of especial interest from the fact that, instead of being constructed of masonry, as is usually the case, only the piers are so made, the superstructure being made of mild steel and practically forming a steel tank nearly 2,000 feet long, 20 feet wide, and 12 feet deep. The main spans, of which there are fifteen, each 130 feet long, are really deep plate girders tied at frequent intervals by cross girders which also sustain the bottom of the tank, the webs of the main girders forming the sides of the tank.

The decision to make the superstructure of steel naturally involved the choice between the use of separate girders for each of the fifteen spans, or the construction of one continuous girder for the entire length of the aqueduct; taking into account the probable introduction of distorting stresses at each joint, in the case of separate girders, the continuous girder was chosen and built.

The selection of steel as the material was not determined upon until after some discussion of the relative merits of steel and iron for such use. Some apprehension was felt that steel was not sufficiently reliable to be used in a structure of such importance, and it was only after numerous tests that a mild steel was chosen. The material used gave, under test, a breaking strength of 60,000 pounds per square inch, an elastic limit of 31,000 pounds, and an elongation of 24 per cent.

In order to provide for the expansion and contraction of this long continuous girder, due to changes in atmospheric temperature, the aqueduct is rigidly secured only to the eighth, or central, pier, and is left free to expand in both directions from the centre. On all the other piers the supports are provided with roller bearings, to permit freedom of movement, as well as wedge adjustments, to allow the level to be restored in case of settling. A double water-tight packing is provided at

each abutment pier, there being an inner U joint of rubber protected by sheet-iron plates, and an outer joint, packed with oakum, to check any leakage past the rubber.

The construction of the substructure of the viaduct offers no especially noteworthy features, except provision for the unusually large stationary load, due to the weight of the tank and its contents. The nature of the soil was ascertained by borings, a hard limestone being found at varying depths, to which caissons were sunk for the pier foundations, the dimensions of the pier being such that a maximum pressure upon any portion of the masonry does not exceed sixty pounds per square inch.

Many interesting details of this important work are given, for which the reader must be referred to the original memoir, which is very clear and complete, and should prove a valuable source of information in connection with future structures of this sort.

Hydraulic Cements in Sea-Water.

THE action of sea-water upon cements is a matter the importance of which must be conceded when it is remembered how extensive and important are the structures of masonry exposed to such action. An eminent Hungarian engineer, Herr Nádory Nándor, contributes a discussion of the subject to the *Zeitschrift des Oesterr. Ingenieur und Architekten Vereines*, and some of the points made are worthy of consideration and investigation.

Several years ago Dr. Wilhelm Michaelis announced, as the result of examination of many masonry structures immersed in sea-water, that Portland cement of the best quality does not resist the chemical action of sea-water so well as does the less expensive Roman cement, or as do the hydraulic limes under certain circumstances. According to the theory of Dr. Michaelis, the soluble sulphates—sulphate of magnesium, of calcium, and of sodium—enter into a substitution combination with the lime which exists in the cement in a free state or is liberated during the hardening. The free lime in this case is converted into sulphate, after which the silicate of lime and alumina is attacked. The mere formation of sulphate of lime causes an appreciable expansion of the mass, to the detriment of the strength of the cement. With the formation of gypsum occurs also the production of sulphate of lime and alumina, which causes a still greater expansion, amounting almost to a disintegration, owing to the large amount of water of crystallization, the result being that, grain by grain, the cement crumbles into a mud, leaving only those portions which are held together by the carbonate of calcium.

In the case of Roman cement all the lime exists in a state of combination, and there is no inclination towards the formation of sulphate. According to the observations of Dr. Michaelis, a good Roman cement resists the action of sea-water remarkably well.

Hydraulic lime, of which the best representative is the hydraulic lime of Teil, from the department of Ardêche, in the south of France, resembles Roman cement very closely in physical properties. When a mortar of this lime is exposed to the action of the air for a sufficient time before submersion, the outer portion of the free lime becomes converted into carbonate, which at ordinary temperatures does not subsequently form sulphate; and it is a well-known fact that concrete blocks made with this lime resist the action of sea-water very well indeed, an example being seen in the case of the breakwater at Boulogne.

As a result of his investigations Dr Michaelis recommends that hydraulic cementing materials containing more lime than is required for the formation of stable hydro-silicate and aluminate may be made suitable for submarine work by an admixture of trass, or puzzolana, thus not only greatly increasing the cementing strength of the mass, but also enabling it to withstand the disintegrating action of the salt water.

Of late there has also appeared a disposition to use granulated blast-furnace slag in connection with Portland cement, and tests made by Prof. Tetmaier at Zurich

showed a marked increase in strength for additions of fifteen per cent. of ground slag.

In commenting upon these views of Dr. Michaelis, Herr Nándor calls attention to the importance of selecting a suitable cement for use with sea-water, and gives some interesting facts about the cement of Santorin, a variety of puzzolana found in the island of that name in the Grecian archipelago. At the time of the construction of the harbor works at Trieste a number of artificial blocks of concrete made with the hydraulic lime of Teil were used, and many of these showed insufficient resistance to blows and pressure. Later works being undertaken, it was decided to use the Santorin cement. The results were good.

The whole subject of the action of sea-water upon cement is one which has been too little investigated, and this paper of Herr Nándor is a timely one in calling attention to the theories and researches of such a high authority as Dr. Michaelis.

Power Gas for Tramways.

THE electric tramways at Lausanne, Switzerland, are of interest because the generators are driven by gas engines using a lean, or producer, gas; from an account of the plant given in *Le Génie Civil* some of the principal features are here given.

The high cost of coal in Switzerland renders economy in fuel a prime consideration in a power plant; so, when the question of motive power was under discussion at Lausanne, comparisons were made between the cost of steam and that of gas power. Several builders of steam engines were willing to guarantee an expenditure of not more than 22 pounds of steam per effective horse power per hour, which, with an evaporation of 8 pounds of water per pound of coal, corresponds to 2.48 pounds of coal per effective horse power per hour. At the same time offers were made by builders of gas-power plant to instal an apparatus which should require not more than 1.137 pounds of coal per horse power, the fuel being consumed in a producer and the gas used in gas engines.

The latter method was adopted, the builders being held under strong contract to fulfil the guarantee; and, as the plant has now been in operation for two years, definite data as to its working may be obtained.

The plant consists of three Crossley gas engines of 130 h. p. each, and three gas generators of the Taylor revolving-bottom type. The gas is generated by delivering a blast of superheated steam and air through a bed of incandescent fuel, the steam being somewhat in excess of the quantity necessary to produce the blast, the gas thus being partly a water-gas and partly a producer gas, and having a higher calorific power than that of ordinary producer-gas. The gas is passed through condensers, scrubbers, and purifiers, and is then delivered to a holder, from which it is drawn to the engines.

According to the experience of the past two years there has been no difficulty with clinker, the cinder being removed by revolving the beds in the generators once a day.

The gas engines are of the double-cylinder type, the cylinders being opposed to each other on the same axis, thus giving an impulse to the crank every revolution. This, combined with the use of a six-ton fly-wheel, gives a steadiness of motion which is found satisfactory in practice. Owing to the cost of water at Lausanne, the cooling water in the cylinder jackets is not allowed to run to waste, but is delivered into a cement-lined tank, where it is cooled by spraying and used again and again.

Each engine is connected directly to an electric generator of the Thury type, the speed being 160 revolutions per minute, and a battery of 300 accumulator elements, with a capacity of 700 ampere-hours, is used to assist in equalizing the load.

The length of the road is a little over eight miles, of which less than a quarter of a mile is on a level. In fact, the Lausanne tramway possesses, it is claimed, more grades and more curves of short radius than any road in Europe, the maximum grade of 11.3 per cent. being one of

the steepest in Europe operated by adhesion alone.

There are twenty-five tram cars, each for thirty-two passengers, and each being provided with two Thury motors of 20 h. p., the current being supplied by sliding overhead trolley. Each car is furnished with an independent electric brake, in addition to the ordinary friction brake, thus providing for possible derangements of either, which might become serious on steep grades.

During the first half of 1898 the total consumption of coal in the entire establishment was 850,000 pounds, and the corresponding output of power was 413,849 kilowatts, or 2.05 pounds of coal per kilowatt. These figures are of more practical value than those which might be obtained from a scientific test, since the coal consumed represents not only that burned during working hours, but also that used at night and at other times, as well as that burned under the boiler which furnishes the distilled water for the accumulators.

With steam engines of the same size, requiring 2.48 pounds of coal per h. p. the corresponding expenditure would be 3.78 pounds per kilowatt; thus an economy of more than 20,000 francs per year is effected by the use of gas-power instead of steam, disregarding the cost of condensing water in the case of the steam power.

It is from such installations that the practical information must be obtained which will lead to the construction of gas engines of large size. With experience in the use of power-gas for general motive power much of the present waste of fuel will be avoided.

The Zeiss Telemeter.

IT has always been deemed desirable that some method should be devised for ascertaining the distance of a visible object without being obliged to resort to the laborious, and in many cases difficult, operation of actual measurement. When the object can be observed from the extremities of a known base-line, the problem is a simple one, but, where only one point of view is possible, it is not so easy. The use of stadia hairs in a telescope involves the presence of a graduated staff at the point observed, and, however advisable in surveying, is therefore out of the question for military purposes; and for isolated observations of unknown objects, seen from a single point of view, the problem has not as yet been solved to the entire satisfaction of either theoretical or practical men.

A new form of telemeter, designed by Zeiss, the famous optician of Jena, is described in a recent issue of *La Revue Technique*, and, as it possesses some points of novelty and has given good results in practice, it may be accepted as at least an advance towards the solution of the problem. The fundamental principle involved is that of the ordinary stereoscope, or rather the stereoscopic effect which appears in natural vision, due to the difference of angle at which an object is seen by the two eyes. As a matter of fact, it is really due to the distance between the eyes that we are able to estimate distances with the unaided vision, and for objects which are within the range of the visual appreciation of this difference of angle it is possible so to train the faculty as to enable fairly accurate estimates to be made.

The small distance between the eyes, however, as well as the limited range of vision, makes the ordinary estimate not much better than a guess, and the Zeiss telemeter aims not only to widen the base-distance and multiply the distance of distinct vision, but also to add a scale from which the distance of the object seen may be found within pre-determined limits of precision.

The increase of base distance, or practical separation of the space between the eyes, had already been accomplished in the so-called telestereoscope of Helmholtz, in which four mirrors were used to multiply the distance about ten times. This device was little more than an optical toy, and was simply used to produce exaggerated stereoscopic effects. Zeiss uses the same principle, employing prisms instead of mirrors, and also adds a double system of lenses, giving a magnifying power as well as a widened base of binoc-

lar vision. If this system were so adjusted as to give perfect stereoscopic effect, the two images formed by the two branches would be superposed, and the result would be a single image of greatly-exaggerated relief. It is possible, however, so to arrange the relation that each object is seen in double, and that the distance between the two images of any object in the field of view varies in proportion to the distance from the observer. By the introduction of graduated scales in the eye-pieces, the distance by which the images of the object in view are separated may be measured, or, more conveniently, the scale may be so graduated as to permit the distance to be read off directly.

For moderate distance—within 3,000 metres—this direct arrangement of scale is fairly satisfactory, and this form has been made for use in the Austrian infantry as an artillery range-finder. For greater distances, and when more precise readings are desired, a micrometer with movable hair is applied, a fine screw being turned until the hair has moved from one image of the object to the second image of the same object, the reading being subsequently taken from the graduated head of the micrometer screw.

Tests made with these instruments show that for a distance of 1,500 meters an error of 0.35 per cent. was made, while for 3,000 meters the error was 0.70 per cent., and for 6,000 meters 1.40 per cent.

The Influence of Moisture in Spinning.

IT has long been known that the condition of the atmosphere exercises an important influence upon the quality and uniformity of yarn, and the superiority of the product of certain localities has frequently been attributed to the weather.

A paper read upon this subject at Hanover by Herr Joh. Körting, and published in the *Zeitschr. des Vereines Deutscher Ingenieure*, examines the advantages claimed for a moist atmosphere, giving photographic enlargements of threads spun under different conditions of moisture, and describing various appliances for producing artificially the degree of humidity which gives the best practical results.

After discussing the conditions of atmospheric humidity, and explaining briefly the meaning of relative humidity, as a percentage of complete saturation, showing also the greatly-increased amount of moisture required to produce a given humidity at high temperatures as compared with lower ones, the author discusses the best conditions for various kinds of work.

The English authority, Dobson, states that a relative humidity of 50 per cent. is correct for cotton spinning, but the experience of the mills at Mulhouse, in Alsace, points to a higher degree of humidity as desirable, from 65 to 75 per cent. being usual for spinning and 60 per cent. for weaving.

When the proper degree of humidity is maintained, the result is a smooth, high-grade yarn, and a greatly-diminished loss by breakage of threads, the output being increased 6 to 10 per cent.

An examination of micro-photographs of threads produced under different conditions of humidity shows a marked difference as to smoothness, those spun in a dry atmosphere being fuzzy, with many loose fibres standing out from the main strand. One of the explanations of the action of the atmosphere is that in dry air the fibres become electrified, and thus repel each other, while a moist atmosphere is not so readily charged with electricity.

Assuming that the condition of the atmosphere is the true cause for the difference in the quality of yarn produced in different localities, there should be no great difficulties in producing artificially the proper degree of humidity, and in practice two methods have been employed for the purpose. In one case the air is charged with moisture in a chamber separated from the spinning room, and then delivered in the course of ventilation, while, in the other method, the moistening apparatus is placed directly in the work-room.

The first method involves some mechanical system of ventilation, in order that the delivery of moist air may be controlled; a pressure blower of some sort is usually employed. The air delivered

from the blower is sometimes passed through a tower filled with lumps of coke upon which water trickles; in other cases the water is sprayed by atomizers directly into the current of air as it passes from the fan. This method, to be satisfactory, must be accompanied by a very complete system of distributing passages, so that the moistened air may be delivered uniformly to all parts of the work-room: otherwise the inequality in the humidity will be apparent in the different parts of the room. As shown by Herr Körting, the distributing flues are placed under the floor, and openings provided so as to give as nearly as possible a uniform atmosphere about all the machines, while an exhaust ventilator maintains a proper circulation.

When the moistening is done directly in the work-room, various forms of apparatus may be used. Formerly open troughs of water were employed, the air being caused to pass over the surface of the water, which was warmed by a steam coil to increase the rapidity of its evaporation; but this method has not proved very satisfactory in practice.

During the past fifteen years various forms of atomizers and moisteners, under such names as "aerophores" and "drosophores," have been introduced, these consisting of devices for spraying water into the incoming air and at the same time deflecting the current upward and about in such a manner as to mix the water with the air so thoroughly as to insure its complete absorption. By placing these devices about the room, suspended from the ceiling, the air, with certain precautions, may be given such a degree of humidity as will largely make up for any deficiency.

Owing to the great variation in the capacity of air to absorb moisture at various temperatures, and to the fact that it is a constant relative, and not absolute, humidity which it is desirable to maintain, no system of moistening is complete which does not take into account the temperature of the room. A slight change in temperature may cause the relative humidity to vary to an extent sufficient to produce a marked effect on the product; this point is especially difficult to manage in warm weather, when artificial warming apparatus is out of use. During winter the relative temperature and quantity of water sprayed may be fairly well controlled, and in all cases reliable hygrometers should be placed in various parts of the room, so that changes in the humidity may be observed and corrected.

The whole subject is one which, in the present state of meteorological science, should be capable of very precise investigation, and the application of such knowledge, with modern mechanical ingenuity, should render it possible to produce and maintain any desired constant state of atmosphere more readily than heretofore.

Normal Building-Sand.

AN important feature in connection with the use of mortars and cements in masonry structures is the nature of the sand used in the mixture; yet in nearly all tests the cement is the main object under consideration, the sand being often rather neglected. It is this fact which gives especial interest and value to the tests, of so-called normal sands selected from various countries, recently conducted by Herr M. Gary at the Berlin Testing Laboratory. From the *Mitt. aus den Kgl. Technischen Versuchsanstalten*, in which the full report appeared, the following abstract of the work is given. It is well that attention has been directed to so fundamental an element in building construction.

Ten different varieties of sand were tested, and, in order that there might be no doubt as to the high quality and character of the samples, care was taken to have them selected by experts of acknowledged reputation in the various countries from which they were obtained.

Two varieties from Germany were tested, one being a crushed quartz from Freienwalde in Prussia, and the other the sand obtained from the Rhine by dredging. Single samples of standard sand were obtained from Austria, Switzerland, Russia, Norway, England, and the United States, and two samples from France, one of these being from Leucate, a natural sand brought down by the mountain streams of the

Pyrenees, and the other a crushed quartz from Cherbourg.

The tests of the ten varieties of sand consisted in a chemical analysis, and a measurement of the loss of weight at red heat, as well as a determination of specific gravity, and size of grains, after which briquettes were made with Portland cement and subjected to tension tests after seven, twenty-eight, and ninety days' hardening under water. Two sets of briquettes were made with each kind of sand, one set containing one part by weight of cement to three of sand, and the other one part of cement to five of sand. The former proportion represents the usual practice in nearly all countries; the latter was used to the extent to which the addition of a greater proportion of sand affects the strength. Very interesting microphotographs were made of the samples of sand, and the difference in the character of the grains was in some cases very marked.

It is impossible to go into the details of these interesting tests, which are fully tabulated and illustrated with diagrams in the original report, but some of the conclusions are here given.

Among other points it was found that the very sharp crushed quartz sand, which under the microscope showed an angular structure, gave a high tension test and a low compression test, while the natural sands, with rather rounded grains, gave proportionally better results in compression. Thus for the American sand, a crushed quartz from Massachusetts, the ratio between the tension and compression tests was 1:5.7, while for the English sand, which, under the microscope showed round smooth grains, the ratio was 1:10.

The resistance to tension for the mixture of three of sand to one of cement was, for the English and American sands, respectively 424 pounds and 451 pounds per square inch, while for compression the figures were 4,300 pounds and 2,560 pounds. The American sand stood among the highest in the tension tests, being equalled only by that from Switzerland, but in the compression tests it was much lower than any other, the next higher being 3,500 pounds per square inch. On the other hand, the only sand which equalled the English sample in compression was that dredged from the Rhine, which also showed a similar rounded granular constitution. This feature is one which is worthy of further investigation, as, if it is possible to obtain high tension tests for a cement by the use of a sharp sand, while at the same time its resistance, when applied in practice with similar sand under compression, is diminished, these facts should be taken into consideration, or else, more properly, both tension and compression tests should be required.

Tests made with mixtures of sands of coarse and fine grains showed inferior results to those obtained with sands uniform in size of grain.

In concluding his report, Herr Gary recognizes the fact that the tests, being made with but one kind of cement and with a limited number of samples of sand, can be considered as giving only general indications of the behavior of the materials. Many additional tests must be made before positive conclusions can be drawn. The results, however, certainly emphasize the importance of taking into account the nature of the sand in connection with tests and uses of mortars and cements, and, if such tests are continued, they may lead to the establishment of an international standard.

Electric Power in Mining.

THE general value of electrical transmission in connection with mining work is now generally understood, and numerous installations have been made. Among the more recent plants for coal mining by electric power one of especial interest is found in the Ziegler mine at Nürscham, of which a very full account is given in successive issues of the *Oesterr. Zeitschr. für Berg und Hüttenwesen.*

In this particular case the shaft had been deepened and the main seams of coal exhausted several years ago, but, certain lower seams having been discovered which offered especial difficulties in working, it was decided to introduce electric power for the exploitation of this new portion of the mine.

The principal features to be contended

with in the installation were the dampness, due to the constant and rapid accumulation of water in the workings, and the thinness of the seams, which greatly limited the working space in some cases.

The electric power is chiefly used for hauling and for pumping, the hauling being performed by chain and cable traction systems with electrically-driven winches; the current is used also for driving blowers, and for lighting.

Notwithstanding the dampness of the workings, it was decided to use uninsulated wires for the greater portion of the distribution, although there is a tension of 500 volts. The main conductor down the ventilating shaft is protected by a cotton wrapping with an additional covering of tarred tape, and a similar protection is used in some of the untimbered parts of the mine, but in most of the system the wire is uncovered, porcelain insulators filled with paraffin being depended upon to secure insulation.

The pumping machinery is varied in character, there being a triple-cylinder stationary pump of a capacity of 3,000 litres per minute, a double centrifugal portable pump, mounted on a car, and a shaft pump of the rotary type, operated by its own motor, and arranged to be slung by chains in the shaft during the work of sinking.

There are several haulage systems employed, the principal one being on the incline connecting the new workings with the original mine, while separate winches are used for the various portions of the new workings, both for hauling on slopes and in shafts.

Most of the motors are of one style and size, thus simplifying the matter of repairs, connections, etc., in the electrical work. Belt connections are made to the machinery and timber framing, with marble and porcelain insulation, is used under the motors.

Although electric cutting machinery is not used in this plant, probably owing to the thin and broken character of the seams,—the use of electric power for all other work in connection with the development of the mine appears to have been the one thing which made the working of this portion possible, and the success of the plant demonstrates that, in cases where the older methods may prove too expensive to permit the profitable winning of poor seams, the use of electric power will sometimes enable the work to be accomplished to advantage.

THE ENGINEERING INDEX

INTRODUCTORY

This Index is issued separately from the Magazine, printed on one side of the paper only, and is supplied to subscribers for THE ENGINEERING MAGAZINE at a nominal charge of fifty cents a year to cover cost. In this form it meets the exact requirements of those who desire to clip the items for card-index purposes.

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Serial publications are indexed on the appearance of the first installment.

The titles and addresses of the journals regularly reviewed are given in full below, but only abbreviated titles are used in the Index. Other abbreviations employed are: Ill=Illustrated; W=Words; Anon=Anonymous.

To avoid the inconvenience of small remittances, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices;—15c. each, or fifteen for $2, forty for $5, and one hundred for $12.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

American Architect. *w.* Boston, Mass.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, Minn.
American Journal of Science. *m.* New Haven, Conn.
American Journal of Sociology. *b-m.* Chicago, Ill.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, Pa.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver, Col.
Annals of Am. Acad. of Pol. and Soc. Sci. *b-m.* Phila., Pa.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, Mass.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Atlantic Monthly. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Journal. *m.* London
Bankers' Magazine. *m.* New York.
Bankers' Magazine. *m.* London.
Bankers' Magazine of Australia. *m.* Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* Berlin.
Board of Trade Journal. *m.* London.
Boston Journal of Commerce. *w.* Boston, Mass.
Bradstreet's. *w.* New York.
Brick Builder. *m.* Boston, Mass.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila., Pa.
Bulletin of Bureau of Am Republics. *m.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington, D. C.
Bulletin of the Univ. of Wisconsin, Madison, Wis.
California Architect. *m.* San Francisco, Cal.
Canadian Architect. *m.* Toronto, Ont.
Canadian Electrical News. *m.* Toronto, Ont.
Canadian Engineer. *m.* Montreal, P. Q.
Canadian Mining Review. *m.* Ottawa, Ont.
Century Magazine. *m.* New York.
Chautauquan. *m.* Meadville, Pa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg, S. A. R.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington, D. C.
Contemporary Review. *m.* London.
Cosmopolitan. *m.* Irvington, N. Y.
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago, Ill.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineer. *w.* New York
Electrical Engineering. *m.* Chicago, Ill.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.
Elektrotechniker. *b-m.* Vienna.

Elektrotechnischer Anzeiger. *s-w.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, O.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering Assn. of the South. Nashville, Tenn.
Engineering and Mining Journal. *w.* New York
Engineering Journal. *s. an.* Stanford Univ., Cal.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, Pa.
Fire and Water. *w.* New York.
Forester. *m.* Washington, D. C.
Forum. *m.* New York.
Foundry. *m.* Detroit, Mich.
Gas Engineers' Mag. *m.* Birmingham, England.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glasers Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Gunton's Magazine. *m.* New York.
Harper's Weekly. *w.* New York.
Heating and Ventilation. *m.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Carpenter and Builder. *w.* London.
Illinois Soc. of Engs. and Surveyors. Peoria, Ill.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *w.* Calcutta.
Indian Engineering. *w.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago, Ill.
Iron Age. *w.* New York.
Iron and Coal Trades' Review. *w.* London.
Iron & Steel Trades' Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
Journal Assn. Eng. Societies. *m.* Phila., Pa.
Journal of Electricity. *m.* San Francisco, Cal.
Journal Franklin Institute. *m.* Phila., Pa.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q* New London, Conn.
Journal Political Economy. *q.* Chicago, Ill.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
Journal Western Soc. of Eng. *b-m.* Chicago, Ill.
Kansas University Quarterly. *qr.* Lawrence, Kan.
Locomotive. *m.* Hartford, Conn.
Locomotive Engineering. *m.* New York.
Locomotive Firemen's Mag. *m.* Peoria, Ill.
Machinery. *m.* London.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore, Md.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Master Steam Fitter. *m.* Chicago, Ill.
Mechanical World. *w.* London
McClure's Magazine. *m.* New York.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, Pa.
Mining and Sci. Press. *w.* San Francisco, Cal
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, Col.
Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. Stuttgart.
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Affairs. *qr.* New York.
Municipal Engineering. *m.* Indianapolis, Ind.
National Builder. *m.* Chicago, Ill.
Nature. *w.* London.
Nature. *w.* Paris.
New Zealand Mines Record. *m.* Wellington, N.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienn
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Physical Review. *b-m.* New York.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineer's Club. *q.* Phila., Pa.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago, Ill.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago, Ill.
Railway & Engineering Review. *w.* Chicago, Ill.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines *m.* Liége.
Sanitarian. *m.* Brooklyn, N. Y.
Sanitary Plumber. *s-m.* New York.
Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweizerisches Bauzeitung. *w.* Zurich.
Science. *w.* Lancaster, Pa.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York
Scribner's Magazine. *m.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, N. Y.
Southern Architect. *m.* Atlanta, Ga.
Stahl und Eisen. *s-m.* Dusseldorf.
State's Duty. *m.* St. Louis, Mo.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, N. J.
Stone. *m.* Chicago, Ill.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago, I l.
Technology Quarterly. Boston, Mass.
Technograph. *yr.* Champaign, Ill.
Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* New York
Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago, Ill.
Western Railway Club, Pro. Chicago, Ill.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, Conn.
Year Book of Soc. of Engs. Univ. of Minn.
Zeitschrift für Lokomotivführer. *m.* Hannover.
Zeitschrift f. Maschinenbau & Schlosserei. *m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ingen. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

Beams.

The Design of Compound Beams. An editorial discussion, with especial reference to the investigations of Prof. Kidwell. 1000 w. Eng Rec—Sept. 10, 1898. No. 22732.

Cathedrals.

The Cathedrals of England. S. Parkes Cadman. A careful survey of these cathedrals with illustrations. 3000 w. Chau—Oct., 1898. No. 22841 C.

Church Architecture.

All Saints, Wittering. C. Lyman. Illustrated description of the peculiar Saxon chancel of this Northamptonshire church. 800 w. Builder—Sept. 3, 1898. No. 22656 A.

Cupola.

Construction of a Cupola on a Hospital. W. Neubecker. Illustrated description of the erection of a piece of ornamental metal work. 500 w. Met Work—Sept 10, 1898. No. 22611.

Goodrich House.

The Goodrich House, Cleveland, O. Illustrated description of a carefully planned building for social settlement work. 1000 w. Eng Rec—Sept. 24, 1898. No. 22895.

India.

The Mogul Architecture of Fathpur Sîkrî. Deals with the historical relations, characteristic forms, and structural and decorative details. 3000 w. Ill. Builder—Sept. 10, 1898. No. 22659 A.

Ironwork.

Notes on the Design and Erection of Architectural Ironwork. Henry A. Cutter. A paper read before the Royal Institute of Public Health. Reviews the development under the influence of costly sites, concentrating population, and demands for light, air, and fire protection. Considers structural shapes and formulates principles of design and erection. 2500 w. Ill. Builder—Sept. 3, 1898. No. 22660 A.

Japan.

The Early Architecture of Japan. Ralph Adams Cram. A historical and critical review. 3000 w. Ill. Arch Rev—Sept., 1898. No. 22663 G.

Masonry.

Masonry. Discusses the nature and properties of the stones employed, the various ways in which they are combined in building construction, and the importance of sound jointing. Ill Car & Build—Aug. 26, 1898. No. 22582 A.

Pueblo Masonry. Cosmos Mindeloff. Describes the characteristics of this masonry. 1500 w. Ill Car & Build—Aug. 26, 1898. No. 22581 A.

Peterborough Cathedral.

Peterborough Cathedral; West Front. Rev. T. Garbett. A historical and architectural commentary. 2200 w. Ill. Arch, Lond—Sept. 2, 1898. No. 22646 A.

Staircase.

The Statics of Overhanging Steps in the Staircase Experiments. (Die Statischen Verhältnisse der Freitragenden Stiegenarme bei den Versuchen des Stufenausschusses.) J. E. Brik. A mathematical discussion of the statical equilibrium of the members of the experimental staircases tested by the Austrian Society of Engineers. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 19, 1898. No. 22911 B.

Steel Construction.

Probable Increase of Steel Construction. Showing the advantages in fire protection, reduction in cost and improvement in materials which make probable the adoption of steel in residence building. 2000 w. Arch & Build—Sept. 17, 1898. No. 22673.

Theatre.

The New Royal Theatre at Wiesbaden. (Das Neue Königliche Theater in Wiesbaden.) With views of the exterior and interior, and plans and sections of the building. The mechanical details are of much interest, and the general design noteworthy, the orchestra being sunk below the parquet, as at Bayreuth. Two articles. 4000 w. Deutsche Bauzeitung—Aug. 13, 17, 1898. No. 22962 each B.

Workmen's Houses.

Working-Class Dwellings in Dublin. Extracts from an address by Sir Charles A. Cameron. Reviews progress in 30 years, influence on sanitation, comfort and morality and municipal bearings of the movement. 1700 w. Arch, Lond—Aug. 26, 1898. No. 22644 A.

HEATING AND VENTILATION.

Auditorium.

Ventilation of Steinert Hall, Boston. A full account of the method of heating an auditorium and music hall in Boston, by means of which the purity of the atmosphere is maintained at all times. 2000 w. Eng Rec—Sept. 17, 1898. No. 22746.

Boilers.

The Condition of Schoolhouse Boilers. Editorial based upon the report of a Massachusetts District Police Inspector, discussing the manner in which boilers in school houses are neglected, and the consequent risk of explosion. 800 w. Eng Rec—Sept. 17, 1898. No. 22740.

Columbia University.

The Heating and Ventilating of Columbia University. G. A. Suter. An explanation of the theory of the heating and ventilating apparatus, describing the details necessary to a proper understanding of the subject. 6000 w. Sch of Mines Quar—July, 1898. No. 22428 D.

Furnace Heating.

A Departure in Furnace Heating. Illustrated description of a system employing round pipes of unusually large area throughout. 1600 w. Met Work—Sept. 10, 1898. No. 22612.

Government Building.

Heating of a Norfolk, Va., Government Building. Describes and illustrates the hot-water system recently installed. 1000 w. Eng Rec—Sept. 24, 1898. No. 22896.

Steam Pipes.

The Computation of the Loss of Pressure in Steam Pipes. (Die Berechnung der Druckverluste in Dampfleitungen.) J. B. Goebel. A mathematical discussion, deriving fundamental equations, and showing their practical application to high and low pressure steam; with sheet of tables for practical use. Two articles. 1 plate. 4500 w. Gesundheits Ingenieur—July 15, 31, 1898. No. 22921 each B.

Ventilating Plant.

Ventilating and Heating of the Singer Building, New York City. Illustrated description of a plant which supplies fresh air to every room of a ten-story building. The direct-indirect system is employed. 2000 w. Eng Rec—Sept. 3, 1898. No. 22537.

PLUMBING AND GASFITTING.

Bathtubs.

The Development of the Bath-tub in New York. A reprinted article discussing the increasing demand for bath-tubs in even the cheapest tenements, the kinds of tubs most used, bathroom accessories, &c. 1000 w. San Plumb—Sept. 1, 1898. No. 22539.

MISCELLANY.

Argentina.

Building in the Argentine Republic. A review of the local peculiarities of design, materials, and construction, legal requirements, and customs as to building contracts. 2800 w. Builder—Sept. 3, 1898. No. 22655 A.

Chimney.

See Mechanical Engineering, Miscellany.

Cowdray House.

Cowdray House and its Owners. J. L. André. Read at the annual excursion of the Horsham Museum Society. Historical review of the ancestral home of the Montague family. 2000 w. Arch, Lond—Sept. 2, 1898. No. 22647 A.

Enameled Brick.

Making Enameled Brick. A brief statement of the methods of working, moulding, dipping, and burning. 1000 w. Brick—Sept., 1898. No. 22607.

Garden.

The New Horticultural Garden of the City of Paris. (Le Nouveau Jardin Fleuriste de la Ville de Paris.) M. Seurat. A general view of the grounds at Auteuil, with details of the structural work of the conservatory buildings and of the heating apparatus. 2500 w. 1 plate. Le Génie Civil—Aug. 13, 1898. No. 22927 D.

Garnier.

Notes upon the Architectural Work of Charles Garnier. J. R. Coolidge, Jr. A study of his designs for large theatres. 2500 w. Ill. Arch Rev—Sept., 1898. Serial. 1st part. No. 22662 G.

Headquarters.

The Octagon House. Brief illustrated description and historical sketch of the house leased in Washington, D. C., for the national headquarters of the Am. Inst. of Archts. 1200 w. Arch & Build—Sept. 3, 1898. No. 22547.

Inscriptions.

On Architectural Inscriptions and Insignia. An argument for the use of appropriate heraldic or literary designations and for the architect's signature, with comment upon some offenses against good taste. 1300 w. Builder—Sept. 3, 1898. No. 22657 A.

Interior Decoration.

Grounds of Walls and Paintings. A discussion of the difficulties of determining a color scheme, the methods of great masters, and the psychological effect. 2200 w. Arch, Lond—Aug. 26, 1898. No. 22643 A.

Lich-Gates.

Lich-Gates. John S. Holbrook. Illustrates and describes these structures, peculiar to England, which are built at the entrance to churchyards so as to form a shelter under which the bier or coffin may rest. 1000 w. Am Arch—Sept. 24, 1898. No. 23044.

Mexico.

Mitla and Other Ancient Cities of Mexico. L. Viajreo. Account of the archæological studies of W. H. Holmes, as drawn from his report, with special reference to architectural features. 1800 w. Ill. Am Arch—Sept. 10, 1898. No. 22675.

Mortar.

The Chemical Examination of Mortar. H. F. Hills. Reports the examination of various samples of old mortar. 800 w. Builder—Sept. 17, 1898. No. 23001 A.

Sand.

Normal Sand. (Normal-Sande.) M. Gary. A report upon the results of the tests at the Berlin Royal Testing Laboratory upon various kinds of building sand, with reproductions of microphotographs of sand from a number of localities. 7500 w. 2 plates. Mitt aus den Kgl Tech Versuchsanstalt—Part 3, 1898. No. 22952 G.

Stone.

Machine vs. Hand-cut Stone. Henry Gorse. On the evils due to the use of machinery, and urging that it be abolished on all buildings whose adornment and durability is a matter of importance. 1800 w. Stone—Sept., 1898. No. 23036 C.

Wind Pressure.

Wind Pressure on Exposed Structures. From the inaugural address of J. Wolfe Barry, before the Mech. Science Sec. of the British Assn. The unnecessary anxiety from hasty generalizations on this subject. 800 w. Jour of Gas Lgt—Sept. 13, 1898. No. 22848 A.

Woodcarving.

Examples of French Woodcarving. Notice of a portfolio of photographic reproductions of French woodcarving in our national museums, edited by Eleanor Rowe. Ill. 2800 w. Builder—Sept. 17, 1898. No. 23000 A.

CIVIL ENGINEERING.

BRIDGES.

Beton.

The Kaiser Bridge at Sarajevo. (Die Kaiserbrücke in Sarajevo.) Josef Schustler. Description and photograph of a combined steel and concrete arch of 83 feet span over the Miljacka river, at Sarajevo, Bosnia. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 9, 1898. No. 22916 B.

Bridge Building.

Bridge Building, Past and Present. (Der Brückenbau, Sonst und Jetzt.) Prof. Mehrtens. A very interesting address delivered before the Technical Society of Frankfurt am Main, with many illustrations of famous bridges. Two papers. 4000 w. Schweizerische Bauzeitung—Sept. 3, 10, 1898. No. 22986 each B.

Combination Truss.

Combination Bridges. A. D. Otteweil. A discussion of the advantages of using iron, steel, and wood, in combination, for bridge trusses, with illustrations and details of several such structures. 1200 w. Engng—Sept. 9, 1898. No. 22716 A.

Disaster.

Bridge Disaster at Cornwall, Ont. With photographs showing the condition of the work at and after the time of the fall of the pier. 1800 w. Eng News—Sept. 15, 1898. No. 22730.

The Bridge Failure at Cornwall, Ont. An account of the failure of this nearly completed bridge, giving such information as is at present available, together with illustrations showing the condition of the structure immediately before and after the failure. 1200 w. Eng Rec—Sept. 17, 1898. No. 22744.

Erection.

Erection of the Albert Bridge by Launching. Describes the interesting features and the methods used in the erection of this railway structure across the river Brisbane, in Queensland, Australia. 1800 w. Eng Rec—Sept. 24, 1898. No. 22890.

Erection of the Lake Street Arch Bridge, Minneapolis. Illustrated description of the erection of a bridge 1,271 feet long, and 120 feet above the bed of a shallow part of the upper Mississippi River. 900 w. Eng Rec—Sept. 24, 1898. No. 22889.

Floating Bridge.

An Old Floating Bridge. C. J. H. Woodbury. Read before the Essex Inst., Mass. Describes a floating bridge at Lynn on the Salem and Boston turnpike, nearly a century old and still in use. 2700 w. Engng—Aug. 26, 1898. No. 22572 A.

Foundations.

Historical Discussion of Pneumatic Foundations. (Beitrag zur Geschichte der Druckluftgründung.) A. Schmall v. Eisenwerth. An account of the early applications of the pneumatic methods of sinking foundations for bridge piers with especial reference to the construction of the railway bridge over the Rhine at Kehl, 1859. Two articles, 10,000 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 2, 9, 1898. No. 22915 each B.

Highway Bridge.

The Davis Avenue Cantilever Highway Bridge, Allegheny City, Pa. Illustrates the strain sheet and some of the more important details of a cantilever highway bridge now being built to span a deep ravine. 700 w. Eng News—Sept. 1, 1898. No. 22461.

Joint.

Experiments upon a Flexible Joint for Riveted Structures. (Expériences sur un Joint Flexible pour Charpentes Metalliques Rivées.) M. Mesnager. The advantages of providing flexibility in certain members of a riveted framework are shown by tests. The recommended forms of construction are illustrated. 2500 w. 2 plates. Ann des Ponts et Chaussées—2 Trimestre, 1898. No. 22951 F+G.

Park Bridges.

Park Bridges. Oscar Sanne. Illustrated description of designs erected in the Milwaukee Lake Park, the aim being to fulfill the engineering requirements and also make the structures of high artistic value. Discussion. 4000 w. Jour of W Soc of Engs—Aug., 1898. No. 22796 D.

Railway Bridge.

Double-Track Steel-Arch Railway Bridge, Muengsten, Germany. Abstract of article by A. Rieppel, in *Zeitschrift des Vereines Deutscher Ingenieure*. Information relating to the design and erection of the bridge, with illustrations of the principal features. 1400 w. Eng News—Sept. 1, 1898. No. 22464.

Replacement.

The Victoria Jubilee Bridge. A brief but clear account of the method of replacing the tubular bridge by a new double-track truss bridge without suspending traffic. 1300 w. Ill. Can Engr—Sept., 1898. No. 22699.

Suspension.

The Covington and Cincinnati Suspension Bridge. A description of the reconstructed bridge, with details of the towers, anchorages and truss work. Serial. Part I. 2500 w. Eng Rec—Sept. 10, 1898. No. 22736.

Swing Bridge.

Turning Machinery for the Rock Island Bridge Swing Span. Illustrated description of the turning machinery of a bridge across the Mississippi. 3600 w. Engng—Sept. 16, 1898. No. 22876 A.

CANALS, RIVERS AND HARBORS.

Antwerp.

The Port of Antwerp. (Le Port d'Anvers.) A. Dumas. With map and plan of the city, and numerous illustrations of the quays, docks, and landing stage. An account of the new quay

wall, now in course of construction is also given. 3000 w. 1 plate. Le Génie Civil—Aug. 20, 1898. No. 22928 D.

Aqueduct.

The Briare Canal Aqueduct. (Pont-Canal de Briare.) M. Mazoyer. A very complete account of the construction of this great canal aqueduct over the Loire, also including smaller aqueducts along the line of the Loire canal. 30,000 w. 9 plates. Ann des Ponts et Chausées—2 Trimestre, 1898. No. 22948 F + G.

Canal Lift.

The Henrichenburg Canal Lift. (Das Schiffshebewerk bei Henrichenburg.) An account of the completion of the work. The weight of the tank and water is counterbalanced by the buoyancy of pontoon tanks, and the raising and lowering effected by screws. Boats of 600 tons displacement are raised 50 feet at one lift. 2500 w. Stahl und Eisen—Sept. 1, 1898. No. 22955 D.

Dams.

Difficulties with Earth Dams in Great Britain. Illustrated description of three dams which were built after unusual plans. 4000 w. Eng Rec—Sept. 3, 1898. No. 22534.

The Computation of Masonry Dams for Reservoirs. (Calcul des Barrages de Réservoirs en Maçonnerie.) M. Barbet. Discussing and extending the recent treatment by M. Maurice Lévy, based upon the elastic theory. 8000 w. Ann des Ponts et Chaussées—2 Trimestre, 1898. No. 22950 F + G.

Docks.

Dock Extensions at Liverpool. Reviews the improvements of the last three decades, specially describing the changes now in progress. Ill. 6500 w. Engr, Lond—Aug. 26, 1898. No. 22573 A.

New Dock at Grangemouth. General description of a new enterprise of the Caledonian railway, the extent of the work and the methods to be employed in carrying it out. It will be a concrete structure, and the earthwork to be disposed of from 3,000,000 to 4,000,000 cu. yds. 1000 w. Arch, Lond—Sept. 2, 1898. No. 22650 A.

The Algiers Dry Dock. A description of the proposed dry dock to be built at Algiers, La., with specifications for material and workmanship. 1200 w. R R Gaz—Sept. 2, 1898. No. 22523.

The New Graving Dock at Glasgow. Giving the detailed specifications for this important structure with plan, and section, also plate of details of caisson gates, and illustration of hydraulic caisson hauling engine. 3500 w. 1 plate. Engng—Sept. 2, 1898. No. 22711 A.

The Stettin Floating Graving Dock. Reprinted from the *Engineers' Gazette*. Gives briefly the history of floating docks, and describes the noteworthy features of the dock named. Ill. 3000 w. Jour Am Soc of Naval Engs—Aug., 1898. No. 22449 H.

Dredges.

Hydraulic Dredges. Statements from a paper by Lindon W. Bates, on high-power dredges and their relation to sea and inland navigation, presented at the International Congress of Navigation, at Brussels. 2800 w. Eng Rec—Sept. 24, 1898. No. 22891.

Sand-Pumping Dredger "Alexander Barminsky." Description, plans, and sections of centrifugal pump suction-dredge built in Holland for the Russian government. 800 w. Engng—Sept. 9, 1898. No. 22717 A.

Elevators.

Pneumatic Grain Elevators. (Ueber Pneumatische Getreideförderung.) M. Buhle. An illustrated description of the Duckham pneumatic system of handling grain as installed in various ports in England and on the continent. Two articles. 5000 w. Zeitschr d Ver Deutscher Ing—Aug. 20, 27, 1898. No. 22903 each D.

Flow.

Calculation of the Flow of Water in Rivers and Canals. (Berechnung der Abflussmengen in Flüssen und Canalen.) A comparison of the new Bazin formula with that of Ganguillet and Kutter, showing both to be based upon the same principles. 1500 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 9, 1898. No. 22917 B.

Foundations.

Sinking Cylinder Foundations in Valparaiso. An illustrated account of the pneumatic foundation work for the new pier now under construction at Valparaiso. 1200 w. Eng, Lond.—Sept. 9, 1898. No. 22701 A.

Haulage.

See Electrical Engineering, Power.

Inundation.

New Orleans' Danger. From the *N. Y. Sun*. An account of the trouble from caving banks of the Mississippi, which threaten some of the most valuable sections. 2300 w. Bos Jour of Com—Sept. 3, 1898. No. 22511.

Levees.

The State Levees of Louisiana. A brief record of the work in Louisiana. There are at present 1194 miles of levees in the State, and 90 miles in Arkansas. 1200 w. Eng Rec—Sept. 24, 1898. No. 22887.

Lighthouses.

The Latest Improvements in the French Lighthouse System. Jacques Boyer. The first portion of a detailed account of the great advances in coast illumination made in France. Many illustrations are given of the improved "lightning flash" optical system. 3000 w. Engineering Magazine—October, 1898. No. 22992 B.

Regulation.

The Regulation of the Elbe and Moldau, and their Tributaries in Bohemia. (Die Flussregulierungen an der Elbe, Moldau und deren Nebenflussen in Böhmen.) Hugo Franz. A general review of the improvements made during the past 50 years, with map and tables of data. 7500 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Sept., 1898. No. 22923 D.

Ship Canal.

The Lake Erie and Ohio River Ship Canal. William Gilbert Irwin. Discusses the economies that will result from the construction of this canal, giving figures from carefully compiled statistics concerning the traffic of this region, the cost, &c. 1700 w. Sci Am—Sept. 24, 1898. No. 22836.

The Manchester Ship Canal. A discussion of the financial position and prospects, based upon the half yearly report. The conclusion is that the earnings will for many years at any rate dissappoint the promoters. 1200 w. R R Gaz—Sept. 9, 1898. No. 22613.

Water Ways.

Geological Water Ways Across Central America. J. W. Spencer. A discussion of the geological and biological evidence of interoceanic connections. Ill. 5500 w. Ap Pop Sci M—Sept., 1898. No. 22440 D.

Weirs.

Recent Experiments upon the Flow of Water over Weirs. (Expériences Nouvelles sur l'Ecoulement en Déversoir.) H. Bazin. A continuation of the author's classic experiments, this series including dams of a great variety of profile, the results being verry fully tabulated. 18000 w, 1 plate. Ann des Ponts et Chaussées—2 Trimestre, 1898. No. 22949 F+G.

IRRIGATION.

Mountain Irrigation.

Difficulties of Mountain Irrigation Engineering. H. A. Crafts. Illustrates various features of mountain construction known as North Fork ditch, in Colorado. 1600 w. Sci Am—Oct. 1, 1898. No. 23083.

Scientific Irrigation.

Irrigation as a Civilizer. Extracts from a paper by F. W. Blackmar, basing his plea upon social considerations, with discussion of the views presented. 3400 w. Gunton's Mag.—Oct., 1898. No. 23112 C.

MISCELLANY.

Bearings.

The Determination of Compass Bearings by the Dial of a Watch. (Comment on Peut s'Orienter dans la Campagne en Faisant Usage de sa Montre.) An astronomical explanation of the method with tables showing the exact method for various months for any hour of the day. 1500 w. La Revue Technique—Aug. 25, 1898. No. 22936 D.

Cement.

Natural Cement Plant at Speeds, Indiana. F. H. Lewis. With views of the mill and the quarry, an analysis of the stone, and a general description of the operation of the plant. 2000 w. Eng Rec—Sept. 10, 1898. No. 22733.

The Manufacture of Slag Cement. E. May, in *Stahl und Eisen*. A description of the manufacture and properties. 1600 w. Ir Age—Sept. 1, 1898. No. 22454.

The Relations of Hydraulic Cementing Materials to Sea Water. (Das Verhalten der Hydraulischen Bindemittel zum Meerwasser.) Nadory Nandor. A review of the investigations of Michaelis and of Tetmaier upon the resistance of Portland cement to the action of sea water. Two articles. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 26, Sept. 2, 1898. No. 22914 each B.

Collapse.

Collapse of a Pier Shed, New York City. Detailing the circumstances under which a partially completed pier shed was blown down during a severe storm. 1200 w. Eng Rec—Sept. 10, 1898. No. 22739.

Colorado.

Notes of an Engineer in Colorado. W. P. H. A review of the engineering features of Colorado Springs and vicinity, of Pueblo, Florence and Cripple Creek, with some related matters of interest. 5500 w. Eng News—Sept. 1, 1898. No. 22463.

Columns.

Diagrams of Johnson's Straight Line Formula for Determining the Strength of Columns. John S. Fielding. Diagrams of interest to engineers with critical letter from Thomas H. Johnson. 800 w. Eng News—Sept. 22, 1898. No. 22832.

Land-Slides.

Land-Slides. Abstract of a discussion before the Institution of Civil Engineers, by Mr. Crowell, giving some especial instances of the behavior of sliding earth in connection with engineering works. 1000 w. Eng Rec—Sept. 10, 1898. No. 22734.

Mortar.

See Architecture and Building, Miscellany.

Pile Driver.

A New Pile Driver. L. S. and M. S. Ry. Five views and descriptive notes of a pile-driver possessing many features of interest. 800 w. Ry Mas Mech—Sept., 1898. No. 22553.

Regulator.

Discharge Regulator and Tests of 14-inch Redwood Water Main, near Los Angeles, Cal. A balancing pan-and-float system is used to control the discharge. Tests of flow for lengths from 4400 to 8900 feet of pipe are given and values of coefficients deduced. 1000 w. Eng News—Sept. 8, 1898. No. 22727.

Retaining Walls.

Earth Pressures on Retaining Walls. G. C. Maconchy. Indicates a simpler and more direct method of calculating the overturning moments, and endeavors to bring the theory within the range of practical utility. Part first recapitulates some of the existing methods. 800 w. Engng—Aug. 26, 1898. Serial. 1st part. No. 22565 A.

Sand.

See Architecture and Building, Miscellany.

Telemeter.

The New Zeiss Telemeter. (Le Nouveau Télémètre Zeiss.) The instrument is based on the exaggerated stereoscopic effect produced by separating the objectives of a field glass by the use of prisms. The method is fully described, and the instrument tested is said to have measured distances of 2000 metres with an error of about 3 per cent. 3000 w. La Revue Technique—Sept. 10, 1898. No. 22940 D.

Wind Pressure.

See Architecture and Building, Miscellany.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

American Trade.

American Trade in British India. Prepared by the Philadelphia Commercial Museum. Hints helpful to the export trade, with brief criticism of American methods, and information concerning iron and steel-made goods. 2500 w. Am Mfr & Ir Wld—Sept. 2, 1898. No. 22548.

Cardiff.

Cardiff as a Port. Considers the causes which have led to the phenomenal development during the last fifty years—the population increasing from 10,000 to 176,000. 3000 w. Col Guard—Sept. 16, 1898. No. 22882 A.

China.

A Recent Business Tour in China. C. A. Moreing. Summarizes the salient features of the chief cities, the internal and external political influences at work, the characteristics of the governing classes and the people, the opening for commercial and industrial expansion, and the means by which the work can best be accomplished. 6500 w. Nineteenth Cent—Sept., 1898. No. 22685.

The Industrial Interests of the United States in the Far East. Wharton Barker. An account of the author's experience in industrial enterprise in China, outlining the general policy which he believes to be necessary to insure success in developing foreign interests there. 3000 w. Engineering Magazine—October, 1898. No. 22991 B.

The Yangtse Valley and Its Trade. Archibald Little. A summary of the physical features, trade movement, business resources, and political aspects. 6000 w. Contemporary Rev—Sept., 1898. No. 22801 D.

Competition.

American Competition. A letter from Arthur Herschmann, praising the American activity and enterprise in business, with editorial comment. 3000 w. Engr, Lond—Aug. 26, 1898. No. 22577 A.

Congress.

The Trades Congress. Editorial discussing the proceedings of the Labor Parliament held at Bristol, England, with especial reference to the proposed regulation of hours of labor, rates of wages, and federation of interests. 2000 w. Engng—Sept. 9, 1898. No. 22718 A.

Cuba.

The Undeveloped Resources of Cuba. G. E. W. Reviews the industries, chiefly agricultural, which offer opportunities for expansion. 1300 w. Sci Am—Sept. 10, 1898. No. 22603.

French Market.

The French Market for American Goods. F. C. Chappel. Discussion of steps necessary to secure better and juster commercial treaties and to advance American trade in France. 1200 w. Am Mach—Sept. 1, 1898. No. 22518.

New Territory.

The Commercial Promise of Cuba, Porto Rico, and the Philippines. George B. Waldron. Considers some of the opportunities for trade opened to the United States by the war with Spain. 2200 w. McClure's Mag—Sept., 1898. No. 22438.

Japan.

The Foreign Trade of Japan. Statistics drawn from the report of Mr. A. H. Lay, Assistant Japanese Secretary to Her Majesty's Legation at Tokio. 3600 w. Ind & East Engr—Aug., 1898. No. 22686 D.

Puerto Rico.

Puerto Rico and Its Resources. Quotation from Mr. Austin, Chief of the U. S. Treasury Bureau of Statistics, descriptive of the population, finances, topography, trade, and industrial opportunities of the island. 4500 w. Arch & Build—Sept. 17, 1898. No. 22674.

CURRENCY AND FINANCE.

Coinage.

Curiosities of American Coinage. Alexander E. Outerbridge, Jr. The subject is presented under four heads—1, The Functions of Money; 2, The Early Colonial Coinage; 3, The Coinage of Private Individuals or Companies; 4, The National Coinage; giving many interesting and important facts. Ill. 5000 w. Ap Pop Sci M—Sept., 1898. No. 22441 D.

Fiat-Money.

The History of Fiat Money and Currency Inflation in New England from 1620 to 1789. Frank Fenwick McLeod. An able and scholarly review of the many foolish and fallacious schemes, their successive collapses, and the attendant periods of bankruptcy and repudiation. 7000 w. Ann Am Acad—Sept., 1898. No. 22684 H.

War Loan.

Lessons of Our War Loan. Frank A. Vanderlip. Reviews incidents of this popular loan and its phenomenal success, the immense amount of clerical labor involved, and the effect upon the financial standing of the United States. 4000 w. Forum—Sept., 1898. No. 22541 D.

GOVERNMENTAL CONTROL.

Grazing-Lands.

Our Public Grazing-Lands. Frederick V. Coville. Concerning the decadence of western grazing-lands, due to the present public-land laws. Considers the limitation of the amount of stock by a *per capita* license, and outlines a plan of limiting the amount of stock to the forage capacity of the area. 4800 w. Forum—Sept., 1898., No. 22544 D.

State Socialism.

Australian Experiments in Industry. Helen Page Bates. A full review and discussion of the development and present management of rail-

ways, telegraph, telephone, and other industrial enterprises under State ownership in the various Australian colonies. 6500 w. Ann Am Acad—Sept., 1898. No. 22683 H.

LABOR.

Benefit Funds.

Benefit Funds in the Lake Superior Iron Mining Industry. William G. Mather. President's address at the annual meeting of the Lake Superior Mining Inst. Suggestions for furthering the good condition of the workmen, such as relief funds, housing, physical condition of the miners, &c. 4400 w. Ir Td Rev—Sept. 1, 1898. No. 22513.

Disputes.

Conciliation Councils in Milan. Commentary on the proposed introduction into Milan of a system analogous to the Conseils de Prud'hommes; summarizes the law and explains the functions of the "colleges of probiviri," which are more than mere boards of arbitration. 1800 w. Arch, Lond—Aug. 26, 1898. No. 22645 A.

Electric Plants.

Municipal Plants. Prof. Bemis. Presented at Detroit meeting of the League of American Municipalities. Notes on the recent progress of municipal electric lighting, with discussion. 5000 w. Pro Age—Sept. 1, 1898. No. 22487.

Labor Handling.

How a Georgia Manufacturer Handles His Men. Wm. Miller. The system and rules which are said to be extremely satisfactory in a brickyard employing colored workmen. 900 w. Brick—Sept., 1898. No. 22610.

Strike.

The Cost of the Engineers' Strike. Summary of the Report of George Barnes, Secretary of the Amalgamated Society of Engineers (Br.), giving the financial statement of the strike, its cause and conclusion. 2300 w. Steamship—Sept., 1898. No. 22688 A.

Wages.

Rates of Wages and Hours of Labor. Comments on information given in the recent report of the Commissioner for Labor on "Changes in Rates of Wages and Hours of Labor in the United Kingdom." 1800 w. Jour of Gas Lgt—Aug. 23, 1898. No. 22508 A.

Wages and Hours of Labor. Editorial on the report from the Labor Department of the British Board of Trade, urging the desirability of avoiding fluctuations in the rate of wages in hours of labor. 2000 w. Engng—Aug. 26, 1898. No. 22566 A.

MISCELLANY.

Address.

The British Association. A condensed report of the Bristol meeting, with an abstract of Sir William Crookes' remarkable presidential address. 2500 w. Eng, Lond—Sept. 9, 1898. No. 22705 A.

Combination.

An Anglo-American versus a European Combination. Richard Temple. Presents facts relative to the strength of the two combinations, giving interesting statements relating to trade, population, areas, sea-coast, industry and production, &c. 4500 w. N Am Rev—Sept., 1898. No. 22439 D.

A Rational Basis for International Co-Operation. Sir Nathaniel Barnaby, K. C. B. A discussion of the friendly relations between England and America, showing the rational basis for co-operation to be the community of interest in maritime affairs. 3000 w. Engineering Magazine—October, 1898. No. 22990 B.

Economics.

Foreign Statistics. Editorial on the economic position of England as shown in the "Statistical Abstract for the United Kingdom" and the "Statistical Abstract for the Principal and Other Foreign Countries." 1800 w. Engng—Sept., 16, 1898. No. 22873 A.

Exposition.

The Universal Exposition of 1900. (Exposition Universelle de 1900.) A review of the present state of exposition matters, with especial reference to the preparations being made by Switzerland for a full representation. 4000 w. La Revue Technique—Sept. 10, 1898. No. 22938.

India-Rubber.

India-Rubber Plantations. Gives possible explanations of the shortness of supply other than the scarcity of material, discusses the proposed cultivation of the Pará tree out of its natural home, not regarding it with favor, but thinks it possible that replanting of denuded territory with the indigenous tree might, in time, prove remunerative. 2000 w. Engng—Aug. 26, 1898. No. 22567 A.

New York as a Rubber-Manufacturing Center. Hawthorne Hill. Reviews the considerations which encourage the location of the manufacturing industries in this city. 1300 w. Ind Rub Wld—Sept., 1, 1898. No. 22434 D.

Some Recent Developments in Rubber Cultivation. Francis Child Nicholas. Discusses the interest in rubber planting in the British West Indies; the writer's views in regard to forestry cultivation and husbandry cultivation. 2000 w. Ind Rub Wld—Sept. 1, 1898. No. 22436 D.

Where Rubber is Plenty, but Gatherers Scarce. From a recent report of the British counsel. W. A. Churchill. Gives information relating to rubber-trees, method in use for curing rubber, and rubber-gathering in Brazil. 1200 w. Ind Rub Wld—Sept. 1, 1898. No. 22435 D.

Patents.

The Work of the Patent Office. A review of the report of the Comptroller of Patents (English), suggesting some improvements in the existing practice. 1500 w. Jour Gas Lgt—Aug. 30, 1898. No. 22634 A.

Petroleum Accidents.

The Report of the Petroleum Committee. Sharp criticism of the findings of the Parliamentary committee appointed to investigate the legislation affecting petroleum storage and the sale and use of mineral-oil lamps. 1200 w. Jour Gas Lgt—Aug. 30, 1898. Serial. 1st part. No. 22633 A.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

Carbide.

The Calcium Carbide Works at Ingleton. F. J. A. Mathews. A description of the first plant erected in England according to the patents of M. Raoul Pictet. The charge is given a preliminary heating by the discharge gases, and the work is completed by the heat of the electric arc. 1800 w. Elect'n, Lond—Sept. 9, 1898. No. 22779 A.

The Manufacture of Calcium Carbide. Abstract of a paper by M. Nicolai, read before the Polytechnical Society at Berlin, reviewing the best methods of manufacture and formulating the important points. Reviews also an American consular report summarizing the condition of the industry in Europe. 1500 w. Gas Wld—Sept. 10, 1898. No. 22632 A.

Corrosion.

On the Electrolytic Corrosion of Water and Gas Pipes by the Return Currents of Electric Tramways. J. A. Fleming. Read before the British Assn. at Bristol. A discussion of the causes and conditions of pipe electrolysis. 5800 w. Elect'n, Lond—Sept. 16, 1898. No. 23008 A.

Electrolysis.

The Electrolysis of the Alkaline Chlorides. (Ueber die Elektrolyse der Alkalichloride.) H. Wohlwill. A very elaborate account of the researches of the author, showing the influence of variations in voltage and current density, and investigating the conditions accompanying the production of hypochlorites and chlorates. 10000 w. Zeitschr f Elektrochemie—Aug. 4, 1898. No. 22982 H.

Gold Plating.

The Electrolytic Deposition of Gold. An abstract of a paper by E. Wohlwill in *Zeitschr. für Elektrochemie*, discussing principally the relations of current density and the temperature of bath to the results obtained. 1000 w. Elec Rev, Lond—Aug. 26, 1898. No. 22782 A.

Nitrogen.

The Electrical Fixation of Nitrogen. Sir William Crookes. Extracts from the presidential address before the British Assn. for the Advancement of Science. Calling attention to the need of some means of "fixing" atmospheric nitrogen. Gives figures demonstrating that it can be done electrically by high-tension discharges with extremely cheap power. 1500 w. Elec Wld—Sept. 24, 1898. No. 22834.

Ozone.

Ozone; its Production and Applications. A description of the Andreoli "ozoniser," which consists of grids bearing numerous points between which electrical discharges take place. 1200 w. Elec Rev, Lond—Aug. 26, 1898. No. 22780 A.

LIGHTING.

Bristol, Eng.

Notes on the Electric Lighting System at Bristol, with Special Reference to Auxiliary Plant. H. Faraday Proctor. Read before the British Assn. An outline of the system with results of the working of some of the auxiliary plant. Alternating current is supplied to private customers, and continuous current is used for the public street-lighting. 2500 w. Elec Rev, Lond—Sept. 16, 1898. No. 23012 A.

Central Stations.

Central Station Statistics. From the American Electrical Directory and Buyers' Manual for 1898. Interesting tables of the central station electric-lighting business of the United States. 600 w. Sci Am Sup—Sept. 17, 1898. No. 22818.

Chamber of Deputies.

The Electric Lighting of the Palais Bourbon, Paris. (Eclairage Electrique du Palais Bourbon, à Paris.) An illustrated account of the isolated plant of the palace of the French Chamber of Deputies, with plan of the building. The generators are driven by double cylinder gas engines. 1500 w. 1 plate. Le Génie Civil—Sept. 10, 1898. No. 22931 D.

Detroit.

The Success of the Detroit Municipal Electric Lighting Plant. An analysis of the report for the year ending June 30, 1898, showing that the city has been most successful in operating its own plant. 2500 w. Eng News—Sept. 8, 1898. No. 22724.

Economies.

Positive and Negative Economies in the Operation of Small Electric Light Plants. E. P. Roberts. An examination of successive stages of the work showing where gains or losses are most likely to occur. Two papers. 1800 w. Elec Engr—Sept. 8, 22, 1898. No. 22758.

Electric Plant.

The St. Joseph Sanitarium Electric Plant. H. B. Coho. An illustrated detailed description of a plant containing features of special interest, located six miles from Monticello, N. Y. 600 w. Elec Eng, N. Y.—Sept. 29, 1898. No. 23017.

Grove Lighting.

Electric Lighting at the Pitman Grove Camp Meeting. Bingham Hood. A quite unusual installation is described, using a series incandescent system, but differing from any other in having no street fixtures, shunt boxes or other cut-outs. Ill. 1000 w. Elec Eng, N. Y.—Sept. 1, 1898. No. 22457.

Screw Thread.

Report of the Committee on Standard Thread for Edison Lamps. (Bericht der Kommission zur Normirung von Edison Gewinden.) The full text of the report to the German Elektrotechnic Society, together with discussion. Enlarged profiles of the proposed thread are given, and the subject of gauges discussed. 3000 w. Elektrotech Zeitschr—Aug. 4, 1898. No. 22968 B.

Supply Cost.

Some Suggestions Relative to Determining the Cost of Electric Supply. M. E. Turner. A paper before the Ohio Electric Light Association discussing a method of distributing the various elements of expense in order to determine the cost of electric supply. 2000 w. W Elect'n—Sept. 10, 1898. No. 22766.

Testing.

Testing Arc Light Circuits. W. H. Markland. Showing the superiority of the voltmeter to the electric call bell for this work, and asserting the unsuitability of the galvanometer for arc circuits. 1000 w. Elec Engr, N. Y.—Sept. 8, 1898. No. 22757.

U. S. Capitol.

Electricity in the United States Capitol. Bushrod C. Washington, Jr. An illustrated account of the electric light and power plant in operation in the Capitol building at Washington. 2500 w. Elec Wld—Sept. 10, 1898. No. 22765.

POWER.

Electric Driving.

The Relative Efficiency of Single and Group Electric Driving and Transmission. (Vergleich der Wirtschaftlichkeit von Elektrischen Einzelbetrieb, Elektrischen Gruppenbetrieb und Transmissionsbetrieb.) E. Hartmann. A discussion of the various conditions under which the different methods give the best results. 3500 w. Die Elektrizität—Aug. 20, 1898. No. 22966 B.

Electric Storage.

Electric Storage in an Edison Station. George P. Low. Illustrates and describes the installation features, and the practical results obtained at the Edison station of the San Francisco Gas and Electric Co. 6800 w. Jour of Elec—Aug., 1898. No. 22545.

Haulage.

Electrical Canal Haulage. Editorial discussing the causes of the decline in transport by canal, and predicting a revival in consequence of the introduction of improved methods; particularly the use of electricity for hauling. 1000 w. Elec Rev, Lond—Sept. 9, 1898. No. 22785 A.

Hydraulic Power.

The Development of the Hydraulic Power of the Hudson River at Mechanicville. Fully illustrated article describing the development of 7000 h. p. and its electrical transmission to Schenectady. 3000 w. Am Elect'n—Sept., 1898. No. 22760.

Industrial Motors.

The Applications of the Electric Motor to Small Industrial Purposes and Its Effects on Trade and on the Community Generally. Alfred H. Gibbings. Read before the British Assn. Considers the reasons why its application has been confined to a few trades, and showing how large a sphere of influence it is destined to fill. 2800 w. Elec Rev, Lond—Sept. 16, 1898. No. 23014 A.

Johannesburg.

The Electric Power Plant of the Rand Central Electric Works. (Die Elektrische Kraftübertragungsanlage der "Rand Central Electric Works.") Walter Klug. A very fully illustrated account of the plant at Johannesburg, S. A. R., including map of the distribution of current to the gold fields. 6000 w. Elektrotech Zeitschr—Aug. 4, 1898. No. 22967 B.

Meters.

Electric Meters for Use with Accumulators. (Elektrizitätszähler für Akkumulatorenbetrieb.) H. Aron. An illustrated article showing various forms of the author's pendulum meter as applied to accumulator driving. 2000 w. Elektrotech Zeitschr—Aug. 18, 1898. No. 22970 B.

The Meters of the Electrical Company, formerly Schuckert & Co. of Nuremberg. (Zähler der Elektrizitäts A. G. vormals Schuckert & Co., Nüremberg.) J. A. Möllinger. A very complete account of the meters made by this well-known concern, for various currents and uses. 5000 w. Elektrotech Zeitschr—Sept 8, 1898. No. 22978 B.

The Meter's Relation to the Dividend. Caryl D. Haskins. Abstract of paper read before the Ohio Elec. Lgt. Assn., August, 1898. Gives advice on the size of meters for variable loads, emphasizes the importance of overload accuracy, and considers other points of interest. 3000 w. Elec Wld—Sept. 3, 1898. No. 22490.

Mine Transmission.

See Mining and Metallurgy, Mining.

Motors.

Alternating Current Motors of Great Starting Power. (Wechselstrommotoren mit Grosser Anlaufskraft.) Max Déri. A paper before the Electrotechnical Society of Vienna, discussing the best armature windings for the purpose. 3000 w, Elektrotech Zeitschr—Sept. 15, 1898. No. 22981 B.

Polyphase Asynchronous Motors. W. G. Rhodes. A description of the Boucherot motor, showing its high starting torque. 1000 w. Elec Rev—Sept. 2, 1898. No. 22784 A.

Multiphase.

Consideration of the Multiphase System for Central Station Service. W. S. Kelley. Discussing the most effective systems for distributing and utilizing multiphase currents for central station power plants. 3000 w, Elec Engr, N. Y.—Sept. 22, 1898. No. 22759.

Tests.

Some Tests with an Induction Generator. A. F. McKissick. Paper presented at meeting of Am. Inst. of Elec. Engs. at Omaha. Describes tests made. 2500 w. Elec Wld—Sept. 3, 1898. No. 22491.

Three-Phase.

Electric Power and Its Application on the Three-Phase System to the Bristol Wagon and Carriage Works. W. Geipel. Read before the British Assn. Discusses the causes of waste of coal in workshops and factories and how it may be obviated by the use of electricity; also the economy in labor, and the attainment of the maximum output of machine tools. 4200 w. Elec Rev, Lond—Sept. 16, 1898. No. 23015 A.

Transmission.

Electric Power of the Dennison Manufacturing Company. With plans showing the use of electric transmission for a manufacturing plant occupying a number of detached buildings. 1800 w. Eng Rec—Sept. 17, 1898. No. 22745.

Transmission of Power by Electricity. Alexander Siemens. Read before the British Assn. A study in detail of the developments. 3800 w. Elec Rev, Lond—Sept. 16, 1898. No. 23013 A.

TELEGRAPHY AND TELEPHONY.

Cables.

The Archæology of Submarine Telegraphy. J. J. Fahre. A historical résumé of the early work with submarine cables from the earliest experiments down to 1840. Two articles. 5000 w. Elec Engr, Lond—Aug. 26, Sept. 2, 1898. No. 22775 each A.

The New French Submarine Cables. (Les Nouveaux Câbles Sous-marins Français.) With sections of the various portions of the cables recently laid between Brest and New York, and between New York and Cape Haytien. 1000 w. Le Génie Civil—Aug. 27, 1898. No. 22926 D.

Copper Wire.

The Introduction of Hard-Drawn Copper Wire. Thomas B. Doolittle. Statement regarding the researches of the writer leading to the use of this wire in the telephone service and the advantages. 800 w. Elec Eng, N. Y.—Sept. 29, 1898. No. 23020.

Fire Alarm.

The Fire Alarm Telegraph System of Baltimore, Md. C. B. Fairchild. Illustrated description. 1000 w. Elec Eng, N. Y.—Sept. 29, 1898. No. 23019.

Space Telegraphy.

Communication by Spark Telegraphy without the Coherer. (Die Abstimmung der Funkentelegraphie ohne Fritter.) Martin Tietz. An account of experiments in which the thermopile and the bolometer were substituted for the coherer. 3000 w. Elektrotech Zeitschr—Aug. 18, 1898. No. 22972 B.

Synchronism in Wireless Telegraphy. An account of experiments by Dr. Martin Tietz, in *Electrotechnische Zeitung*. 1100 w. Elec Rev, Lond—Sept. 16, 1898. No. 23011 A.

Wireless Telegraphy. Abstract of a lecture by Monsignor Molloy, delivered before the Royal Dublin Society, descriptive of the work of Marconi. 800 w. Arch, Lond—Sept. 2, 1898. No. 22648 A.

Telephone Call.

The Automatic Pendulum Telephone Call. (Les Postes Télephoniques à Appel Pendulaire.) L. Montillot. A description of the system installed by the Omnibus Company of Paris. A pendulum and dial system is used, by means of which any station can call any other, without interrupting communication. Two articles. 3000 w. L'Electricien—Aug. 20, 27, 1898. No. 22964 each B.

Valley Telephone Co.

The Exchanges of the Valley Telephone Company, Saginaw, Michigan. History of the formation of the company, with illustrated description of the exchanges, the underground work, cables, line construction and accessories. 3000 w. Elec Engng—Sept., 1898. No. 23003.

MISCELLANY.

Address.

Address to the Mathematical and Physical Section. W. E. Ayrton. Delivered to Section A of the British Association, and dealing with the relations of mathematical and physical science to applied electricity and engineering. 3500 w. Elec Engr, Lond—Sept. 9, 1898. No. 22777 A.

Presidential Address before the International Magnetic Conference. A. W. Rücker. Abstract, with editorial. Protests against the interference of terrestrial observations caused by proximity of electric tramways, and discusses other subjects of interest to the association. 5000 w. Elect'n, Lond—Sept. 16, 1898. No. 23007 A.

Aluminium.

Aluminium as an Electrode in Cells for Direct and Alternate Currents, E. Wilson. A record of experiments made with aluminium plates as electrodes, using various solutions and currents. Serial. Part 1. 2000 w. Elec Rev, Lond—Sept. 9, 1898. No. 22787 A.

Armatures.

Armature Winding and Connections. Arthur L. Rice. A description of the Wenström windings, with diagram showing the manner in which the wire is laid upon the armature. 1000 w. Am Elect'n—Sept., 1898. No. 22763.

Battery.

The Jacques Carbon Battery. John W. Langley. Endeavors to show that no new theory need be put forth to explain the action of this battery, but only an old one applied. 1800 w. Jour Fr Inst—Sept., 1898. No. 22530 D.

Cell.

A Simple Form of Daniell Standard Cell. (Ueber eine Einfache Form des Daniell'schen Normalelementes.) O. Grotrian. Describes a simple form, sufficiently constant for practical use, and more readily made than the Clark or Weston cells. 2000 w. Elektrotech Zeitschr—Aug. 18, 1898. No. 22971 B.

Charging Cells.

A Comparison between Charging a Secondary Cell at Constant Potential and at Constant Current, More Especially as Regards Efficiency. A. A. Cohen and J. M. Donaldson. Read before the British Assn., Section A. Reports a series of tests to determine the efficiencies obtained with the two methods. 4000 w. Elect'n, Lond—Sept. 16, 23. Serial. 2 parts. No. 23006 each A.

Conductors.

The Formula for Most Economical Section of

Electrical Conductors. (Note sur la Formule Economique des Canalisations Electriques.) D. Dujon. A mathematical examination of Lord Kelvin's law, with applications to practical examples. 2500 w. La Revue Technique—Aug. 25, 1898. No. 22935 D.

The Relative Costs of Copper, Aluminium, and Iron, when used as Electrical Conductors. J. B. C. Kershaw. A comparison of the cost and relative conductivity of the three metals, showing that at present prices aluminium is the most expensive. 1000 w. Elec Rev, Lond—Sept. 2, 1898. No. 22783 A.

Currents.

Parallel and Series Arrangement of Alternating Currents of Different Curve Forms. (Parallel und Reihenschaltung bei Wechselströmen von Beliebiger Kurvenform.) G. Roessler. A discussion of the character of a combined current when the wave curves are other than sinusoidal in form; the subject being mathematically treated. 4000 w. Elektrotech Zeitschr—Sept. 1, 1898. No. 22976 B.

Door Openers.

Electric Door Openers for Elevators. Explains the action of pneumatic door openers and describes an electric operating device. Ill. 1200 w. Elec Eng, N. Y.—Sept. 29, 1898. No. 23018.

Dynamometer.

A New Transmission Dynamometer. William Ernest Dalby. Read before the British Inst. of Civil Engs. Treats of a new mechanism for measuring the deformation of the spring, and describes a self-contained dynamometer. Ill. 1800 w. Am Mach—Sept. 22, 1898. No. 22817.

Efficiency.

The Determination of the Efficiency of a 220 Kilowatt Generator and Turbine with Vertical Connecting Shaft. (Bestimmung der Elektrischen Verluste Eines mit einer Turbine Gekuppleten 220 Kilowatt Drehstromgenerators mit Vertikaler Welle.) K. P. Täuber. Details of the test are given, the total loss being about 5 per cent. 2000 w. Elektrotech Zeitschr—Sept. 1, 1898. No. 22977 B.

Electrical Accessories.

Modern Installation Accessories According to the Rules and Standards of the German Electrotechnical Society. (Ueber Neuere Installationsmaterialien nach den Sicherheitsvorschriften und Normalien des Verbandes Deutscher Elektrotechniker.) R. Hundhausen. With numerous illustrations of switches, fuses, cut-outs, and other accessories. 5000 w. Elektrotech Zeitschr—Aug. 25, 1898. No. 22973 B.

Electromotive Force.

The Dependence of Electromotive Force of a Galvanic Element upon the Thermochemical Relations. (Ueber die Abhängigkeit der Elektromotorischen Kraft Galvanischer Elemente von der Thermochemischen Daten.) G. Platner. Showing the existence of a relation between the galvanic and thermochemical action and their interdependence—Serial. Part 1. 1800 w. Elektrochemische Zeitschr—Aug., 1898. No. 22985 H.

Exciting.

A Method of Exciting Continuous Current Generators with Half the Pressure at the Brushes. (Schaltungsanordnung zur Erregung von Gleichstrom Nebenschlussmaschinen mit der Halben Bürstenspannung.) A. Sengel. By the introduction of a contact ring and third brush, a current of half the brush voltage may be derived and used for excitation. The details of the method and its advantages are described. 3500 w. Elektrotech Zeitschr—Aug. 11, 1898. No. 22969 B.

Galvanometer.

The Ballistic Galvanometer and Some of Its Applications. W. H. Freedman. Explains the theory of the instrument, and gives mathematical demonstrations. 5000 w. Sch of Mines Quar—July, 1898. No. 22431 D.

Isolated Plants.

The Efficient Use of Steam and Labor in Isolated Plants. Percival R. Moses. A comparison of the various elements of cost in isolated plants and a study of the relation which they bear to the efficiency of the whole. 2500 w. Engineering Magazine—October, 1898. No. 22999 B.

Magnetism.

Terrestrial Magnetism. A. E. Cotterell. A discussion as to whether the earth is really a huge magnet, or merely the recipient of an ethereal line of force. Serial. Part 1. 1200 w. Elec Rev, Lond—Sept. 9, 1898. No. 22786 A.

The Effect of the Fibrous Structure of Sheet Iron on the Changes in Length Accompanying its Magnetization. Edward Rhoades. Introductory remarks and description of experiments having for their object the determination of the effect which the grain exerts on the magnetic changes in length and in the magnetization. 4300 w. Phys Rev—Aug., 1898. No. 22798 D.

Manufacturing.

Electrical Manufacturing Interests. Thomas Cummerford Martin. Discusses electrical manufacturing development in the United States and the conditions which favor it, with the future outlook. 2000 w. Chau—Oct., 1898. No. 22842 C.

Permeameter.

The Kath Industrial Permeameter. (Pérmeametre Industriel du Dr. Hubert Kath.) MM. Aliamet and Brunswick. The instrument is based upon that of Marcel-Deprez, and enables permeability to be determined within the limit required by practice. 2000 w. L'Electricien—Sept. 17, 1898. No. 22965 B.

Polarization.

The Polarization Capacity of Reversible Electrodes. (Polarisationskapazität Umkehrbarer Elektroden.) Elsa Neumann. A mathematical investigation based on the method of Warburg. 2000 w. Zeitschr f Elektrochemie—Aug. 18, 1898. No. 22983 H.

Recorder.

An Alternating Cycle Curve Recorder. Hugh L. Callendar. Describes a new piece of appa-

ratus intended to reduce the labor involved in the study of alternating-current phenomena by means of the delineation of the curves which represent the mode of variation of the pressure and current, throughout the cycle. 4000 w. Elect'n, Lond—Aug. 26, 1898. No. 22594 A.

A Reliable Method of Recording Variable Current Curves. J. A. Switzer. Describes investigations carried on in the Physical Laboratory of Cornell University, in the hope of adding something to the work of Dr. A. C. Crehore. 3200 w. Phys Rev—Aug., 1898. No. 22799 D.

Resistances.

The Galvanometer in the Bridge System. W. J. Murphy. Reports some experiments made which yielded rather remarkable results and led to an investigation and gave an additional reason for the use of the D'Arsonval type of galvanometer for bridge work. 700 w. Elect'n, Lond—Aug. 26, 1898. No. 22595 A.

Rotary Converters.

The Rotary Converter in Street Railway Work. Louis Bell. Explains what the rotary converter is, how it operates in practice, and under what circumstances it becomes economically available for railway work. Ill. 5000 w. St Ry Jour—Sept., 1898. No. 22498 D.

Supply.

The Supply of Electricity to Large Districts. A review of the report of the Joint Parliamentary Committee as to prospective legislation upon the distribution of Electricity. Serial. Part I. 2500 w. Eng, Lond—Sept. 9, 1898. No. 22702 A.

Transformer.

The Theory of the Transformer. (Theorie der Umformer.) Gisbert Kapp. The first instalment of a serial treating of the theory of the rotary converter, discussing the general principles upon which the transformation of currents is based. Part I. 2000 w. Elektrotech Zeitschr—Sept. 15, 1898. No. 22980 B.

Voltage.

Voltage Curves in Breaking Inductive Resistances. (Spannungskurven bei Ausschaltung Induktiver Widerstände.) Fr. Natalis. A record of tests made upon coils with various windings and cores. The Joubert disc was used, and the data are given with the respective curves. 1800 w. Elektrotech Zeitschr—Sept. 1, 1898. No. 22975 B.

MARINE ENGINEERING.

Balancing.

The Taylor Method of Balancing Marine Engines. (Das Taylorsche Verfahren zur Ausbalanzirung der Schiffsmaschinen.) C. Fränzel. A review of the method originally given by D. W. Taylor in the Jour. Am. Soc. Naval Engineers, for determining the crank angles and distribution of forces to produce a minimum vibration. 4000 w. Zeitschr d Ver Deutscher Ing—Aug. 13, 1898. No. 22902 D.

Cruiser Engines.

Engines of the French Armored Cruiser "Chanzy." Principal dimensions and brief illustrated description. 500 w. Engng—Sept. 16, 1898. No. 22870 A.

Indicating.

Indicating Marine Engines. Lewis M. Ellison. Directions for indicating, with a study of diagrams. 700 w. Engr, N. Y.—Sept. 15, 1898. No. 23063.

Marine Engine.

Modern Type of Vertical-Inverted Triple-Expansion Marine Engine. Illustrated description of a type which is being used on small vessels. 400 w. Marine Engng—Sept., 1898. No. 22806 C.

Ocean Liners.

Our Great Ocean Liners. Interesting information, with illustrations, from the latest edition of Rhodes' Steamship Guide. 1500 w. Transport—Sept. 16, 1898. No. 23049 A.

Rafts.

Sea-Going Rafts on the Pacific. E. K. Bishop. Describing the construction and manipulation of the great lumber rafts, the introduction of which has caused a revolution in the transportation of lumber between Pacific Coast ports. 35000 w. Engineering Magazine—October, 1898. No. 22998 B.

Rowing.

Some Interesting Rowing Experiments. E. Cuthbert Atkinson, in *Natural Science*. Describes a recording indicator for rowing experiments, the diagram and the method of treating it, giving some account of results obtained from 27 experiments. 3300 w. Sci Am Sup—Sept. 3, 1898. No. 22471.

Shipyard.

The Lorain Shipyard of the Cleveland Shipbuilding Co. With general plan showing the arrangement of the slips and buildings, also plan, section, and details of the 500 ft. dry dock. 1800 w. Eng News—Sept. 8, 1898. No. 22722.

Shipyard Work.

See Mechanical Engineering, Compressed Air.

Steamships.

Great Steamships. (Les Grands Paquebots.) M. L. de Chasseloup-Laubat. A general review of the great ocean liners, from the Savannah, 1819, to the Kaiser Wilhelm der Grosse, with many illustrations of notable vessels. 50,000 w. Bulletin de la Société d'Encour—Aug., 1898. No. 22932 G.

Submerged Ships.

Submerged Ships and Their Salvage. Fred Hood. Gives briefly the history of the attempts at rescue work, the manner of work, and the dangers encountered by divers. 2000 w. Chau—Oct., 1898. No. 22843 C.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

Boilers.

See Architecture and Building, Heating.

Boiler Selection.

The Choice of a Boiler. Editorial showing the importance of taking local conditions into account in the selection of a steam boiler, and the minor influence of first cost as compared with cost of maintenance. 1500 w. Eng, Lond—Sept. 2, 1898. No. 22709 A.

Coal Dust.

Novelties in Coaldust Firing Apparatus. From *Thonindustrie Zeitung.* Illustrated description of mixers and feeding apparatus. 900 w. Col Guard—Sept. 16, 1898. No. 22881 A.

Corrosion.

A Peculiar Case of Corrosion. An account of sudden and intense corrosive action in a boiler, with explanation. Ill. 1300 w. Locomotive—Aug., 1898. No. 22899.

English Practice.

Steam Boiler Practice in England. Gives the essential points of a paper by J. J. Steinitz, read before the Municipal Electrical Assn. (England). It gives the most advanced practice in England. 2500 w. Am Mach—Sept. 1, 1898. No. 22516.

Explosions.

Boiler Explosion at Buffalo, N. Y. Account of an accident at the National Starch Mfg. Co.'s plant, with description of the battery and the conditions before and after the explosion. 1000 w. Min & Sci Press—Sept. 10, 1898. No. 22678.

Boiler Explosions. A review of the Board of Trade inquiry into an accident to a Cornish boiler at Bradford. 1800 w. Eng Mech—Aug., 1898. No. 22597.

Feed Water.

The Engineering Chemistry of Boiler Waters. Henry Leffman. A paper before the Engineers' Club of Phila., reviewing the chief impurities, their source, action, and removal. 2800 w. Am Gas Lgt Jour—Sept. 19, 1898. No. 22640.

Flat Heads.

Investigation of Distortion and Resistance of Flat Heads. Prof. C. Bach. Reprinted from *American Machinist.* The investigations cover flanged heads of wrought and cast material, deducing formulæ. Ill. 1200 w. Jour Am Soc of Naval Engs—Aug., 1898. No. 22446 H.

Fuel Gas.

Dellwick's Water Gas. An illustrated description of the producer, the process, and the properties, cost, and applications of the gas. Translated from Teknisk Tidskrift by *The Iron Age.* 2000 w. Pro Age—Sept. 15, 1898. No. 22626.

Smoke. A reference to the cause of smoke, the possibilities of prevention by the use of gaseous fuel, and especially the Dellwick process as an economical solution. 1600 w. Pro Age—Sept. 15, 1898. No. 22625.

Injectors.

Boiler Feeding by Injectors. James Whitcher. A discussion of the objections to the injector as a boiler feeder, comparing its advantages and disadvantages. 1200 w. Elec Rev, Lond—Aug. 26, 1898. No. 22781 A.

Locomotive Boiler.

How to Lay Out a Locomotive Boiler. Henry J. Raps. Method of laying out the throat sheet and upper one-half of connection. Ill. 700 w. Loc Engng—Sept., 1898. No. 22550 C.

Mechanical Draft.

The Economical Aspects of Mechanical Draft with Special Reference to Central Stations. Walter B. Snow. Presents the conveniences and advantages claimed for mechanical draft, and its importance to central station managers. 1800 w. R R Gaz—Sept. 2, 1898. No. 22525.

Mining Boilers.

Steam Boilers for Mining Purposes. William Kent. The principles governing their economical and efficient use. The influence of local conditions on the size and type of boilers, and an impartial study of best types of boilers for varying conditions at mines. 3000 w. Mine & Min—Sept., 1898. Serial. 1st part. No. 22479 C.

Peat.

Compressed Peat as Fuel. A description of the peat bogs of Ontario, Canada, and the operations there conducted of compressing peat for steam-raising fuel. Comparative evaporative tests with peat and coal are given. 1200 w. Can Elec News—Sept., 1898. No. 22791.

Water-Tubes.

Water-Tube Boilers. J. Alvah Scott. A discussion of Mr. Darwin Almy's paper on this subject in the Feb. number, considering the elements that tend to shorten the life of water-tube boilers and the precautions necessary for their care, &c., both in the torpedo-boat boiler and for commercial service. 5400 w. Jour Am Soc of Naval Engs—Aug., 1898. No. 22444 H.

COMPRESSED AIR.

Air Lift.

The Lifting of Water by Compressed Air. (Druckluft-Wasserheber.) E. Josse. A review of the development of the air-lift, from the time of Löscher in 1797 to Pohlé at the present time, with examples of various actual installations. 4500 w. Zeitschr d Ver Deutscher Ing—Sept. 3, 1898. No. 22905 D.

Compressor.

Compression of Air by Direct Action of Water. Herbert W. Umney. From a paper read before the Society of Engineers. Deals with an improved method of compressing air, illustrating experimental plant and stating the advantages of the method. 3000 w. Ry & Engng Rev—Sept. 17, 1898. No. 22830.

Compressed Air Plant at Ainsworth, B. C. Describes and illustrates an apparatus for com-

pressing directly by falling water, without the use of any moving mechanism. 1200 w. Can Elec News—Sept., 1898. No. 22790.

Liquid Air.

Liquid Air. George F. Barker. A lecture delivered at the Friends' Inst. Lyceum, Philadelphia. Part first reviews the history of the liquefaction of gases, giving some account of the work of various experimenters. 2500 w. Sci Am Sup—Sept. 24, 1898. Serial. 1st part. No. 22840.

Liquid Air, Its Production and Properties. Samuel A. Tucker. Briefly reviews the history of the liquefaction of gases, especially of air, and discusses the properties of liquid air, describing interesting experiments. 5500 w. Sch of Mines Quar—July, 1898. No. 22429 D.

Locomotive Works.

The Compressed-Air Plant in the Locomotive Works at Leinhausen near Hanover. (Die Pressluft-Einrichtungen der Lokomotiv-Werkstatt Leinhausen b. Hannover.) With plan of the works and numerous illustrations of pneumatic lifts, hammers, drills, and other tools. An extensive and interesting plant. 3000 w. Glaser's Annalen—Aug. 1, 1898. No. 22919 D.

Re-Heating.

Device for Re-heating Compressed Air in Pumps. Edward A. Rix, in *Modern Machinery*. Illustrated description of apparatus. 1000 w. Col Guard—Aug. 26, 1898. No. 22562 A.

Ship-Yard Work.

Experiences with Compressed Air in Shipbuilding and Ship-yard Work. William Burlingham. Interesting particulars of work done by pneumatic machines, with illustrations. 2500 w. Marine Engng—Sept., 1898. No. 22805 C.

ENGINES AND MOTORS.

Clearance.

Computing Clearance in Steam Engines. Illustrates and describes four methods of finding clearance. 1600 w. Power—Sept., 1898. No. 22557.

Compound Engines.

Compound Non-Condensing Engines for Office Buildings. Editorial review of all published data concerning advantages of simple and compound types. 1600 w. Eng Rec—Sept. 3, 1898. No. 22532.

Compression.

Experiments on the Compression of Steam in the Clearance Space. M. Dwelshauvers-Dery. Report of experiments demonstrating not only that compression is not detrimental, but that it is indispensable for the attainment of maximum efficiency. 7000 w. Jour Am Soc of Naval Engs—Aug., 1898. No. 22445 H.

The Compression of Steam in the Clearance Space. (Sur la Compression de la Vapeur dans l'Espace Mort.) Dwelshauvers-Dery. An account of the author's further tests upon the experimental engine at the university of Liége, together with a reply to the recent comments of Prof. Boulvin. 10,000 w. Revue de Mécanique —Aug., 1898. No. 22947 H.

Efficiency.

The Efficiency of Steam Engines. Editorial, together with the report of the Thermal Efficiencies Committee of the Institution of Civil Engineers, discussing the basis for a comparison of the efficiency of steam engines. A valuable paper. 5000 w. Elect'n, Lond—Sept. 2, 1898. No. 22778 A.

Engine Accident.

A Peculiar Engine Accident. Illustrates and describes the accident at the Tracy St. station of the Syracuse, N. Y., Rapid Transit Railway Co., on Aug. 1, 1898. 1300 w. Power—Sept., 1898. No. 22556.

Engine Frame.

Strengthening an Engine Frame. Charles A. Hague. Illustrates and describes repairs to a vertical steam engine which was threatened with serious breakdown. 1600 w. Am Mach—Sept. 22, 1898. No. 22815.

Engine Room.

Systematic Work in the Engine Room. W. H. Wakeman. Calls attention to details needing care. 2200 w. Sci Mach—Sept. 1, 1898. No, 22453.

Failures.

Engine Failures. Editorial on the last report of Michael Longridge, to the Engine, Boiler, and Employers' Liability Insurance Co., Limited. 900 w. Engng—Sept. 16, 1898. No. 22874 A.

Gas Engines.

Experiments on the Direct Use of Blast Furnace Gases in Motors. (Expériences sur l'Emploi Direct des Gaz des Hauts-Fourneaux dans les Machines Motrices.) Aimé Witz. A detailed account of the tests made at Cockerill's works at Seraing, Belgium. 2500 w. Revue Universelle des Mines—Aug., 1898. No. 22-944 H.

Experiments with a Simplex Motor Using Blast-Furnace Gas. Account of an extended trial of a high-power single-cylinder engine, describing the manner and conditions of the test and giving many data. 2000 w. Gas Wld—Sept. 10, 1898. No. 22630 A.

Some Notes on the Modern Commercial Gas Engine. W. C. Peebles. A paper read before the North British Association of Gas Managers, sketching the history of the gas engine, the development of its important features, and making a particular argument for the engine made by the writer. 6500 w. Am Gas Lgt Jour—Sept. 12, 1898. No. 22637.

Some Notes on the Modern Commercial Gas-Engine. W. Carmichael Peebles. Read before the North British Assn. of Gas Managers. Gives briefly the history of the Otto cycle gas-engine, and the changes which have taken place since first brought out, recent improvements and the benefits from the invention. Also discussion. Ill. 5000 w. Jour of Gas Lgt—Sept., 1898. No. 22509 A.

Heat Motors.

The Theory of Heat Motors. (Zur Theorie der Wärmemotoren.) Donat Banki. A mathematical examination of the Carnot cycle, and a

discussion of its applicability to actual motors. Many diagrams and tables. 7000 w. Zeitschr d Ver Deutscher Ing—Aug. 13, 1898. No. 22900 D.

Indicators.

The Effect on the Indicator Diagram of Various Changes in the Valve, Eccentric or Governor Connections of an Engine. A. H. Eldredge. Gives diagrams taken by students in Sibley College, Cornell University, with explanations. 1000 w. Power—Sept., 1898. No. 22558.

The Indicator and Its Uses Aboard Ship. R. W. Jack. Read before the Inst. of Engrs. & Shipbuilders at Hong Kong. A somewhat elementary description of the indicator and its use, with discussion of typical diagrams. Ill. 7600 w. Steamship—Sept., 1898. No. 22689 A.

Universally Incorrect Indicator Practice. Tecumseh Swift. Calls attention to some errors in the use of indicator diagrams. 1500 w. Am Mach—Sept. 15, 1898. No. 22814.

Oil Engine.

Campbell Portable Oil Engine. Brief description and illustrations of 20 h. p. petroleum engine. The jacket water is cooled and reused, and the engine is entirely independent of any fixed connections. 800 w. Engng—Sept. 2, 1898. No. 22713 A.

Thermal Efficiency.

The Thermal Efficiency of Steam Engines. The report of the committee of the Institution of Civil Engineers, in connection with a standard basis for steam engine trials. An important paper. Two articles. 3500 w. Engr, Lond—Sept. 2, 9, 1898. No. 22710 each A.

Valve Gear.

Port Openings and Eccentricity. (Kanalweite und Excentrizität.) A. Ehrlich. With diagrams showing the relation between the width of port and throw of eccentric. 1200 w. Zeitschr d Ver Deutscher Ing—Sept. 10, 1898. No. 22909 D.

Steam Engine of 500 H. P., with Zvonicek Valve Gear. (500 Pferdige Dampfmaschine mit Ventilsteuerung von Zvonicek.) Illustrating an inproved form of poppet valve gear with automatic cut-off. 800 w. Zeitschr d Ver Deutscher Ing—Sept. 3, 1898. No. 22906 D.

POWER AND TRANSMISSION.

Belting.

Notes on Belting; Tests of Leather, Rubber, Cotton, and other Belts. G. R. MacLeod. From "Digest of Physical Tests." A very thorough discussion of stresses, joints, and fastenings, and of the results of tests on many specimens of many varieties of belting. 5800 w. Brick—Sept., 1898. No. 22609.

Gas Power.

The Gas Power Station of the Lausanne Electric Tramways. (Station Génératrice à Gaz Pauvre des Tramways Electriques de Lausanne.) P. Leprince-Ringuet. Description and illustration of 400 h. p. plant in 3 units, using producer gas, and driving the electric generators for the Lausanne electric tramways. 1200 w. 1 plate. Le Génie Civil—Aug. 20, 1898. No. 22929 D.

Power Plant.

American Apparatus for the Metropolitan Electric Supply Company of London. Illustrations and description of the 2500 unit, generators and engines, as photographed while under construction. 1500 w. 1 plate. Am Elect'n—Sept., 1898. No. 22761.

Pulleys.

The Strength of Pulley Arms. C. H. Benjamin. Illustrates and describes a series of experiments on pulley arms, carried on in the mechanical laboratory of the Can. School of Applied Science, The tests were made on cast-iron pulleys, and steel-rim pulleys. General conclusions are given with tabulated results. 2300 w. Am Mach—Sept. 22, 1898. No. 22816.

SHOP AND FOUNDRY.

Boring.

Boring and Finishing Cylinders in the Horwich Shops of the Lancashire and Yorkshire Railway. F. J. M. Illustrated description of special machine-shop operations carried on in these works. 1300 w. Am Mach—Sept. 8, 1898. No. 22808.

Brass Founding.

A Talk on Brass Founding. Chas. Vickers. Read before American Foundrymen's Association. Reviews the peculiarities of the metal, the special difficulties, and the means for overcoming them. 3000 w. Foundry—Sept., 1898. No. 22696.

Casting.

A Phenomenal Piece of Bronze Casting. Description of the work of moulding and casting the largest single piece of bronze ever poured in the United States—a statue of Pan. 3000 w. Sci Am—Sept. 10, 1898. No. 22604.

Cost Keeping.

Effective Methods of Finding and Keeping Shop Costs. Henry Roland. A complete account of the minutely-divided accounts of a signal manufacturing company, showing the precision with which costs estimated from previous records agreed with the results on the completion of work. 5000 w. Engineering Magazine—October, 1898. No. 22994 B.

The Card-Index System of Cost Keeping. Illustrated description of the methods used by the Bullard Machine Tool Co., of Bridgeport, Conn. 2500 w. Am Mach—Sept. 15, 1898. No. 22812.

Drilling.

Special Drilling Tools. A. H. Cleaves. Illustrated detailed description. 600 w. Am Mach—Sept. 15, 1898. No. 22813.

Gages.

A New System of Gages for the Planer. Illustrated description of a gaging appliance in use by the Bullard Machine Tool Co., Bridgeport, Conn. 500 w. Am Mach—Sept. 8, 1898. No. 22810.

Hardness Test.

A Test for Determining the Hardness of Cast Iron. C. A. Bauer. Read before American Foundrymen's Association. The test proposed is by counting the revolutions needed to drill to a certain depth under uniform conditions. Duplicates agree closely. 1300 w. Foundry—Sept., 1898. No. 22695.

Index Wheel.

Originating the Index Wheel of the Cornell Dividing Engine. H. B. M'Cabe. Sketch and description. 400 w. Am Mach—Sept. 8, 1898. No. 22807.

Ovens.

An Oven for Dry Sand Molds. I. B. Thomas. Illustrated detailed description of a down-draught oven which gave great satisfaction. 3000 w. Foundry—Sept., 1898. No. 22691.

Pulley Arms.

The Evolution of the Pulley Arm. R. D. Moore. Discusses the motives which actuated the designer of the curved arm, and strongly advocates the straight form. Ill. 1400 w. Foundry—Sept., 1898. No. 22692.

Rolling Mill.

A New Rolling Mill Arrangement. (Neue Walzenstrassenordnung.) E. Weber. A system of adjacent mills with rolls at different heights, by means of which the bars may be passed continuously from one to the next. 1500 w. Stahl und Eisen—Sept. 1, 1898. No. 22956 D.

Rotary Molds.

Rotary Molds for Casting Pig Iron. J. M. Hartman. Illustrated description of a casting machine and the accompanying arrangement of the troughs and the iron notch. Ill. 1300 w. Ir Age—Sept. 22, 1898. No. 22800.

Shop Operations.

The Educational Values of Machine Shop Operations. Abstract of paper by C. P. Benns, read at a recent meeting of the American Manual Training Assn. 2200 w. Am Mach—Sept. 8, 1898. No. 22809.

Superintendence.

Dividing the Responsibility of Foundry Superintendency. Thos. D. West. Argues against relieving the foreman of responsibility for securing right grades of iron in castings. 2600 w. Foundry—Sept., 1898. No. 22693.

Vice Work.

Hints on Vice Work for Young Fitters. F. H. Suggestions for holding work in the vice for the purpose of filing or other operations. Ill. 2000 w. Mech Wld—Aug. 26, 1898. No. 22583 A.

Winding.

Spring Winding Attachments. Describes fixtures used by the writer in the making of helical springs. Ill. 2500 w. Am Mach—Sept., 8, 1898. No. 22811.

Works.

The Works of Messrs. Brown, Boveri and Co. An illustrated description of this important Swiss electrical machinery works with especial reference to its prominence in connection with polyphase work on the continent. 3000 w. Elec Rev, Lond—Sept. 9, 1898. No. 22788 A.

MISCELLANY.

Address.

Sir J. Wolfe Barry's Address. Given before the Mechanical Science Section of the British Association at Bristol. 7000 w. Engr, Lond—Sept. 16, 1898. No. 22879 A.

Automobiles.

Description of the Mechanism of the New Serpollet Vehicles. (Description du Mécanisme des Nouvelles Voitures "Système Serpollet.") A sheet of details with description of the improved Serpollet generator, engine, and driving gear as applied to an automobile. 1500 w. 1 plate. La Revue Technique—Sept. 10, 1898. No. 22938 D.

New York's Electric Cab Service. A very complete paper showing the construction of the 100 motor cabs now in public service in New York, with an account of the practical operation of the work of the Electric Vehicle Company. 4500 w. Am Elect'n—Sept., 1898. No. 22762.

The Brouhot Automobile Carriage. (Voiture Automobile Brouhot et Cie.) Brief description, with illustrations of a break and a phaeton, together with a plan showing the driving mechanism. A petroleum motor is used, with a variable speed gear device. 800 w. 1 plate. La Revue Technique—Aug. 25, 1898. No. 22937 D.

The Cabs and Central Station of the Electric Vehicle Company of New York. Illustrated detailed description. 3500 w. Elec Eng, N. Y.—Sept. 1, 1898. No. 22458.

The Competition of Automobile Cabs. (Concours des Voitures de Place Automobiles.) The official report of the recent competition of automobile cabs in Paris, under the auspices of the Automobile Club of France. A plate of profiles of the three routes is given, and illustrations of the vehicles. Two articles. 1 plate. 12,000 w. Le Génie Civil—Sept. 3, 10, 1898. No. 22930 each D.

The New Station of the Electric Vehicle Company. Illustrated description of the finely equipped station in New York City, with brief mention of the essential points and improvements in the vehicles. 3500 w. Elec Wld—Sept. 3, 1898. No. 22489.

Balance.

The Design and Construction of a Sensitive Laboratory Balance. N. R. Hopkins. A statement of the physical principles involved, of the proportions of the different parts of the apparatus, and the mechanical operations of its manufacture. Illustrated. 2200 w. Sci Am Sup—Sept. 10, 1898. No. 22606.

Beam.

The Statical Computations for a Beam Reinforced by a Catenary. (Zur Statischen Berechnung des durch einen Balken Versteiften Kettentragers.) Anton Rytir. A very full mathematical treatment for various conditions

of loading, forming a valuable contribution to analytical mechanics. 10,000 w. Oesterr Monatschr f d Oeffent Baudienst—Sept., 1898. No. 22924 D.

Chimney.

The Highest Chimney in America. W. P. Hardesty. Illustrates and describes the stack of the Omaha and Grant Smelter at Denver, Colo., which is exceeded in height by but four in the world. 900 w. Eng News—Sept. 1, 1898. No. 22465.

Coal Handling.

The Transportation and Handling of Coal. (Ueber Kohlen-Transport und Lagerungs-Einrichtung.) M. Buhle. A paper before the German Society of Mechanical Engineers, with descriptions and illustrations of the devices used at many continental ports and terminals. Three articles, four plates. 15,000 w. Glaser's annalen—Aug. 1, 15, Sept. 1, 1898. No. 22918 each D.

Enamel.

Enamels of High Expansibility for Use with Wrought or Cast Iron. (Etude d'Emaux à Hautes Dilatations pour Fonte ou Fer.) M. Saglio. A discusssion of enamels based upon various borates, such as borocalcite and pandermite, showing that enamels can be made of such expansibility as to be successfully used upon iron. 9000 w. Bulletin de la Société d'Encour—Aug., 1898. No. 22933 G.

Furniture.

Office Furniture, Engineering Department, Metropolitan Waterworks. Giving details of drawing cases, drawing tables, blue print apparatus, etc., as used by the Metropolitan Water Board, Boston. 3500 w. Eng Rec—Sept. 17, 1898. No. 22741.

Resistance.

Moments of Resistance and Core-Sections for Given Laws of Deformation. (Widerstandsmomente und Kernfiguren bei Beliebigen Formänderungsgesetz.) Fr. Engesser. A discussion, based upon Hooke's law of the proportionality of strain to stress, with formulas and tables for the computation of moments and sections. Two articles. 7500 w. Zeitschr d Ver Deutcher Ing—Aug. 13, 20, 1898. No. 22901 each D.

Rope Splicing.

A Rapid Method of Splicing Wire Ropes. W. H. Morris. Illustrates and describes a method by which a rope can be spliced in from twenty to thirty minutes. 700 w. Mines & Min—Sept., 1898. No. 22485 C.

Slide Rule.

The Slide Rule in Everyday Work. Angus Ballard. An explanation of its uses and advantages as a time-saver. 2700 w. Mines & Min—Sept., 1898. No. 22478 C.

Spinning.

The Moistening of the Air in Spinning and Weaving. (Die Anfeuchtung von Luft in Spinnereien und Webereien.) J. Körting. A paper showing the importance of maintaining the proper degree of moisture in the air of spinning and weaving factories, with microphotographs of the fibers. 4000 w. Zeitschr d Ver Deutscher Ing—Aug. 27, 1898. No. 22904 D.

Steam Pipes.

See Architecture and Building, Heating.

Testing.

International Association for Testing Materials. Notice of the first meeting of the American Section, with announcement of the appointments of the American members on the international committees. 800 w. Eng Rec—Sept. 10, 1898. No. 22735.

Transportation.

Transporting Heavy Masses without the Use of Wheeled Vehicles. W. F. Durfee. Describes a method of carrying a heavy weight a distance by manual power, in use by the Chinese. Ill. 900 w. Am Mach—Sept. 1, 1898. No. 22517.

MILITARY ENGINEERING.

Armed Europe.

The Armed Strength of Europe. Table showing resources in the event of a general conflict, prepared for the *World Almanac* by Lieut. W. R. Hamilton. 650 w. Sci Am Sup—Sept. 3, 1898. No. 22470.

Armorclads.

The First Battle Between Modern Armorclads. An account of the battle at Santiago, on July 3, 1898, reprinted from the *Literary Digest*, and agreeing practically with official reports. 3000 w. Jour Am Soc of Naval Engs—Aug., 1898, No 22447 H.

Balloons.

The Balloon in Warfare. H. Hergesell. A review of recent achievements in æronautical science, due largely to the demands of modern warfare, discussing the systems of various countries in the use of the captive balloon. 5000 w. Forum—Sept., 1898. No. 22540 D.

Battleships.

United States Battleships, Maine, Missouri and Ohio. Gives the chief characteristics of these sea-going coast-line battleships authorized by Congress. 5500 w. Jour Am Soc of Naval Engs—Aug., 1898. No. 22450 H.

Destroyers.

Torpedo-Boat Destroyers. Data from circular issued by the Navy Department, giving the elements of design, machinery, etc. 2000 w. Jour Am Soc of Naval Engs—Aug., 1898. No. 22452 H.

Evaporating Plant.

Evaporating Plant of U. S. S. Rainbow. A description of the evaporating and distilling plant. 2000 w. Jour Am Soc of Naval Engs—Aug., 1898. No. 22448 H.

Gun Carriage.

Barbette Carriage for the U. S. 10-inch Breech-loading Rifle. With detailed illustrations and description, showing the general construction and the arrangement of the recoil mechanism. 1000 w. Engng—Sept. 2, 1898. No. 22712 A.

Monitors.

United States Monitors, Arkansas, Connecticut, Florida, and Wyoming. Extracts from a circular issued by the Navy Department, giving the elements of design. 1800 w. Jour Am Soc of Engs—Aug., 1898. No. 22451 H.

Naval Battle.

The Destruction of Cervera's Fleet. I. As Seen by an Eye-Witness on the "Brooklyn," Commodore Schley's Flagship. George E. Graham. II. As Seen by an Eye-Witness on the "New York," Admiral Sampson's Flagship. W. A. M. Goode. Very fully illustrated. 9800 w. McClure's Mag—Sept., 1898. No. 22437.

The Official Report on the Wrecked Spanish Warships. Abstract and summary of conclusions of the investigating board, with comparison of the results with the forecasts. 2000 w. Sci Am—Sept. 10, 1898. No. 22605.

Naval Parade.

Return of the Victorious Fleet from Cuba. An illustrated account of the naval parade of Admiral Sampson's fleet at New York, Aug. 20, 1898. 1200 w. Sci Am—Sept. 3, 1898. No. 22467.

Naval Warfare.

Ships of War in Action. Reviews the results of the naval warfare in the late Spanish-American war, giving interesting and valuable information. 5000 w. Engr, Lond—Sept. 16, 1898. No. 22377 A.

Torpedo Craft.

Discussion of the Merits of Torpedo Craft and Some of the Features of Design and Construction. William A. Fairburn. Part first discusses the uses and design of torpedo craft, the type of boat needed, the difficulties, &c. 4000 w. Marine Engng—Sept., 1898. Serial. 1st part. No. 22804 C.

U. S. S. Oregon.

Recent Performances of the U. S. S. Oregon. Charles A. E. King. An interesting report of the voyage of this vessel from Puget Sound to Florida, her fine condition, and her part in the battle of July 3, 1898. 1600 w. Jour Am Soc of Naval Engs—Aug., 1898. No. 22443 H.

MINING AND METALLURGY.

COAL AND COKE.

By-Products.

Modern Appliances for Recovery of By-Products from Coking Coal. A translation from the German, dealing with Westphalian practice. Summarizes the conditions affecting quantity and quality of distillation products and describes recovery apparatus. 1100 w. Am Gas Lgt Jour—Sept. 19, 1898. No. 22639.

The Recovery of By-Products in Coke Making. (Anlagen zur Gewinnung der Nebenproducte im Kokereibetrieb.) Rudolf Terhaerst. Notes on the construction of the ovens and the condensing apparatus for the recovery of tar, ammonia, and benzol. 2500 w. Stahl und Eisen—Aug. 15, 1898. No. 22953 D.

Valuation of Crude Carbolic Acid. Carl E. Smith. From the Am. Jour. of Pharmacy. Considers the impurities of the commercial article, the methods of examination, and the difficulties met. 3000 w. Am Gas Lgt Jour—Sept. 19, 1898. No. 22642.

China.

Coal and Iron in Eastern China. C. D. Jameson. An illustrated account of this region, with its geology, and the remarkable coal and iron field. 2800 w. Eng & Min Jour—Sept. 24, 1898. No. 23009.

Coal Dust.

Damping Coal Dust at German Collieries. A translation of the police ordinances concerning the sprinkling of dust in the collieries of the Dortmund district. 1800 w. Col Guard—Sept. 2, 1898. No. 22750 A.

Coke Manufacture.

The Use and Manufacture of Coke in the Iron and Steel Industries. Discusses the economic value of coke and the method of its preparation, referring to the experiments of M. Louis Campredon, and his conclusions. Describes the fuel which has been employed in the blast furnace, and the changes, cost and economy. 2000 w. Col Guard—Aug. 26, 1898. No. 22563 A.

Colliery.

Birley Collieries. A general description of the plants at East and West Birley, Derbyshire, with illustration of the picking bands. 1000 w. Col Guard—Sept. 9, 1898. No. 22752 A.

Rotherham Main Colliery, Yorkshire. A general description, with photograph of headgear and plans of workings, haulage, shafts, &c. 2500 w. Col Guard—Sept. 2, 1898. No. 22747 A.

Colombia, S. A.

A New Field for the Development of Coal and Petroleum. C. F. Zeilinger. Information concerning the extent and character of the coal and petroleum resources of Colombia, S. A., from one who resided in the country more than seven years. Ill. 1700 w. Ir & Coal Trds Rev—Aug. 26, 1898. No. 22580 A.

Entries.

Gob Entry vs. Narrow Entry. Joseph Cain. The methods of working at the Thomas mines, Whitwell, Tenn. A description of the two methods and the conditions under which the gob entry method is more economical than the narrow. Ill. 3000 w. Mines & Min—Sept., 1898. No. 22477 C.

Otto Ovens.

The Otto Coke Oven and the German Coke Industry. A compilation from two papers recently published in Germany, showing the enormous advance in by-product saving recently made in the Ruhr district, and the part played therein by the Otto oven, the structure and working of which are described. 4400 w. Ill. Ir & Coal Tr Rev—Sept. 9, 1898. No. 22672 A.

Preparation.

Mechanical Preparation at the Saint-Eloy Collieries, France. An abstract of a paper by M. de Margues before the Société de l'Industrie Minérale, describing the French methods of screening, cleaning, and washing coal. 2500 w. Col Guard—Sept. 9, 1898. No. 22751 A.

Southern Coal.

Southern Coal and Coke Review of one year's operations in the principal fields of the Southern United States. 1700 w. Mfrs Rec—Sept. 2, 1898. No. 22486.

Treveskyn Mine.

Treveskyn Mine. Illustrated description of the surface and haulage arrangements at this new mine of the Vulcan Coal Co., in the Pittsburg district. 1200 w. Mines & Min—Sept., 1898. No. 22480 C.

Victoria.

The Coal Resources of Victoria. Perry F. Nursey. Shows the progress and satisfactory position of the industry and the remarkable development since 1890. 1800 w. Ind & Ir—Sept. 16, 1898. No. 22886 A.

Washing.

Notes on Coal and Coke. C. A. Meissner. Read before the Mining Society of Nova Scotia. Deals with coal and coke for blast-furnace use, especially with reference to the comparative benefits of washing. 1200 w. Can Min Rev—Aug., 1898. No. 22588 B.

Water Shaft.

Gilberton Water Shaft. George B. Hadesty. The method employed for draining the Gilberton and Draper collieries; the reasons for its adoption; the methods employed in sinking and timbering and the machinery used in hoisting the water. Ill. 3000 w. Mines & Min—Sept., 1898. No. 22474 C.

COPPER.

Newfoundland.

Copper and Pyrites in Newfoundland. Robert H. Jones. Some account of these ores and other mineral deposits of the island. 2500 w. Can Min Rev—Aug., 1898. No. 22586 B.

Saxony.

The Mansfeld Copper Mines. (Le Mansfeld.) Alphonse Dory. Describes the geological features of the district, and the mines and smelters of the Mansfeld Company, in the Harz mining region of Saxony. 7500 w. Revue Universelle des Mines—Aug., 1898. No. 22946 H.

Volumetric Analysis.

A New Volumetric Method for the Determination of Copper. Richard K. Meade. Read before the American Chem. Soc. Description of a permanganate method which is said to be rapid and sufficiently accurate. 1300 w. Ind & Ir—Sept. 9, 1898. No. 22665 A.

West Kootenay.

Long Distance Transmission Plant of the West Kootenay Power and Light Company. An illustrated account of the development of the falls of the Kootenay River, in British Columbia. 2000 w. Can Elec News—Sept., 1898. No. 22789.

GOLD AND SILVER.

Assaying.

The Assay of Telluride Ores. Charles H. Fulton. Describes work undertaken to determine where the difficulty and losses lie, and if possible to remedy these defects of the assay by proper methods and precautions, giving conclusions. 1800 w. Sch of Mines Quar—July, 1898. No. 22432 D.

Cassiar.

The Mineral Wealth of Cassiar. Report of the Dease Lake country and the probable mineral wealth of the Stikine. 1600 w. Can Min Rev—Aug., 1898. No. 22585 B.

Coolgardie.

The Coolgardie, Australia, District. John Dwyer. Information of some of the mines about Coolgardie. 1800 w. Min & Sci Pr—Aug. 27, 1898. No. 22472.

Cyanide.

Cyanide Experiments upon Dry Ores of Southern Slocan District. W. S. Johnson. Gives the results of experiments carried out by the writer. 5000 w. Can Min Rev—Aug., 1898. No. 22589 B.

Practical Cyanidation of Tailings and Ores. Alfred S. Edgecombe. Remarks on the practical treatment of tailings and ores gained by some years' experience in Australia. 2500 w. Can Min Rev—Aug., 1898. No. 22587 B.

The Siemens & Halske Process in the Transvaal. (Der Siemens & Halske Prozess in Transvaal.) H. Pauli. Showing the extent to which the process has been introduced, and its advantages over the MacArthur-Forrest process. 1200 w. Zeitschr f Elektrochemie—Sept. 1, 1898. No. 22984 H.

Darien.

The Darien Gold-Mining Region in Colombia. Eduardo J. Chibas. A fully illustrated account of the re-opening of these ancient Spanish workings, with a description of their modern development. 4000 w. Engineering Magazine—October, 1898. No. 22995 B.

Gold Mill.

The Hadley, N. Y., Gold Mill and Its History. J. Nelson Nevius. Illustrates and describes the process which is being tried on a commercial scale at the mill of the Sacondaga Mining and Milling Co., near Hadley, Saratoga Co., N. Y. 1600 w. Eng & Min Jour—Sept. 3, 1898. No. 22519.

Idaho.

Mt. Caribou Gold Deposits. Arthur Lakes.

A description of the Teton mountain country of Idaho and the formations of the ores found. 1400 w. Mines & Min—Sept., 1898. No. 22-476 C.

Kalgoorlie.

Mines of Kalgoorlie, Australia. John Dwyer. A letter descriptive of the various properties, the lodes, yields, and physical and financial condition, very favorable to the region. 2500 w. Min & Sci Press—Sept. 3, 1898. No. 22677.

Klondike.

A Winter's Work in the Klondike. Tappan Adney. Letter and illustrations giving an idea of the conditions prevailing in this region. 5500 w. Harper's Wk—Oct. 1, 1898. No. 23002.

Gold and Other Resources of the Far West. J. A. Latcha. A description of the rich mineral fields of the west, the steps necessary for their development and the changes of recent years. Urging specially the building of railroads through the rich mineral regions. 5000 w. Forum—Sept., 1898. No. 22543 D.

The Pilgrimage to the Klondike and its Outcome. Frederick Palmer. Gives briefly the history of gold-seeking in this region, the present conditions, and future outlook. 5500 w. Forum—Sept., 1898. No. 22542 D.

Mercur, Utah.

Gold Mines of Mercur. Don Maguire. A description of one of the most peculiar formations of gold ore in the world. History of the early difficulties met with in treating the ore, the resulting ups and downs of the district, and its final success. 3000 w. Mines & Min—Sept., 1898. No. 22484 C.

New Zealand.

The Gold Mines of New Zealand. (Les Mines d'Or de la Nouvelle-Zélande.) F. Schiff. A general descriptive paper, with illustrations of the more important workings. 2500 w. Le Génie Civil—Aug. 27, 1898. No. 22925 D.

Ores.

Deceptive Appearances of Ores. Arthur Lakes. Notes some common mistakes. 800 w. Mines & Min—Sept., 1898. No. 22481 C.

Placers.

The Gold Placers of the Eastern Oural Mountains, Russia. H. B. C. Nitze. A short outline of the geology, character of the beds and method of working. Illustrated. 1200 w. Eng & Min Jour—Sept. 10, 1898. No. 22600.

Slimes.

Discrepancies in Slime Treatment. W. A. Caldecott. Notes on the assays of slime residues for total gold, and on the determination of the specific gravity of dry slimes. Also discussion. 4000 w. Jour Chem & Met Soc of S. Africa—July, 1898. No. 22584 E.

West Kootenay.

Notes on Lardeau and Cariboo Creek Mining Divisions, West Kootenay, B. C. Harry Bush. An account of discoveries made, advantages, and general information of the district. 3000 w. Can Min Rev—Aug., 1898. No. 22590 B.

IRON AND STEEL.

Blast Furnaces.

The Management of Blast Furnaces. E. S. Cook. An account of the writer's experiences, discussing fluxing, fuels, ores, blast, management and modern construction. 10,500 w. Can Min Rev—Aug., 1898. No. 22591 B.

Brittleness.

Brittleness Produced in Soft Steel by Annealing. J. E. Stead. Read before the Iron & Steel Institute. Discusses the definitions of terms, the different kinds of brittleness, causes of its development, and remedies. 4000 w. Ir & Coal Tr Rev—Sept. 9, 1898. No. 22670 A.

Cementation.

The Micro-Chemistry of Cementation. John Oliver Arnold. Read before the Iron & Steel Inst., at Stockholm. Describes the details of the method, and reports the micro-chemical analyses of a series of bars. 2300 w. Ir & St Trds Jour—Sept. 3, 1898. No. 22820 A.

Diagram.

A Diagram for Finding the Transverse Strength of Steel Rails. Diagram for computing the transverse strength for weights up to 100 lbs. per yd., with explanation by W. M. Wickham. 500 w. Eng News—Sept. 22, 1898. No. 22833.

Flux.

Flux Spar in Metallurgical Work. Discusses its use in the blast furnace, the open-hearth steel furnace, and the foundry cupola. 1000 w. Ir Trade Rev—Sept. 8, 1898. No. 22623.

Forgings.

A Comparison of the Hollow Bored Method and the Fluid Compression Hollow Forged Method of Making Steel Forgings. George H. Bryant. Illustrated description of methods used at the Krupp Works, and why they are used. Written discussion by H. F. J. Porter, with closure by author. 6800 w. Jour of W Soc of Engs—Aug., 1898. No. 22797 D.

Grangesberg.

The Grängesberg Iron-Ore Mines. A description of the occurrence of the ore, methods of exploitation and working, separation, power-installation, and labor conditions. 2700 w. Ill. Ir & Coal Tr Rev—Sept. 9, 1898. No. 22671 A.

Hot-Blast.

The Heating of the Blast for Blast-Furnaces. (Die Winderwärmung an den Hochöfen.) F. Braune. A discussion of the advantages of heating the blast, with illustrations and descriptions of the more recent hot-blast stoves. 3500 w. Zeitschr d Ver Deutscher Ing—Sept. 10, 1898. No. 22907 D.

Jones Process.

Carnegie Mixer Patent Sustained. An abstract of the opinion of Judge Buffington in the action of the Carnegie Steel Co. vs. the Cambria Iron Co., sustaining the complaint. 3200 w. Ir Trade Rev—Sept. 8, 1898. No. 22620.

Lake Superior Region.

Iron-Ore Manufacture at Marquette. Extend-

ed abstract from a report by John Birkinbine. The first portion deals with ore supply, production, transportation, fuel, flux, etc. 4000 w. Ind & Ir. Serial. 1st part. No. 22666 A.

Manganese Irons.

Manganese in Cast Iron and Some Experiments Thereon. Guy R. Johnson. Read before American Foundrymen's Association. Presents results of some physical tests suggesting commercial use for high manganese iron, especially for brake shoes. 2200 w. Foundry—Sept., 1898. No. 22694.

Metalloids.

On the Action of Metalloids on Cast Iron. Guy R. Johnson. Read before the Iron & Steel Institute, Stockholm meeting. A discussion of the effect of each element on the properties of the iron and on the state of the other metalloids, with tables of tensile tests in which each element in turn is varied, the others being held constant. 2800 w. Ind & Ir—Sept. 9, 1898. Serial. 1st part. No. 22667 A.

Rolling Mill.

See Mechanical Engineering, Shop & Foundry.

Slag.

Basic Slag in the Martin Process. (Thomasschlacke im Martinbetrieb.) O. Thiel. An examination of the chemical composition of the slag produced by the basic open hearth furnace with various kinds of charges. 3000 w. Stahl und Eisen—Aug. 15 1898. No. 22954 D.

Solution Theory.

The Solution Theory of Iron and Steel. Hanns Juptner von Jornstorff. Read before the Iron & Steel Inst., at Stockholm. The paper is a continuation of the writer's researches on the application of the laws of solution to the case of iron and steel. 2500 w. Ir & St Trds Jour—Sept. 10, 1898. No. 22835 A.

Steel Works.

The Donnarfvet Works. A brief account of the works of Stora Kopparbergs Bergslags Aktiebolags and the Sandvik Works. Ill. 1200 w. Ir & Coal Trds Rev—Aug. 26, 1898. No. 22579 A.

Sulphides.

On the Diffusion of Sulphides Through Steel. E. D. Campbell. Read before the Iron & Steel Inst. at Stockholm. A description of experimental work, and a statement of results 1300 w. Ir & St Trds Jour—Sept. 3, 1898. No. 22319 A.

Swedish Iron.

Characteristic Features of Swedish Iron Ore Mining. G. Nordenstrom. Read before the Iron and Steel Inst., Stockholm. The geographical distribution of iron ores, their occurrence, nature and composition are considered, use of magnetic instruments in exploring, prospecting by means of diamond drilling, methods of working, ventilation, &c. 10,300 w. Col Guard—Aug. 26, 1898. No. 22561 A.

The Development of the Swedish Iron Industry. Richard Akerman. Read before the Iron and Steel Inst., Stockholm. Historical review. 6000 w. Col Guard—Aug. 26, 1898. No. 22559 A.

The Iron Ore Deposits of Kiirunavaara and Luossavaara. Hjalmar Lundbohm. Read before the Iron and Steel Inst., Stockholm. An account of these large deposits in Sweden, describing their situation, area, quality, various types, &c. 4400 w. Col Guard—Aug. 26, 1898. No. 22560 A.

The Iron Ore of Northern Sweden. A narrative of the visit of the members of the Iron and Steel Institute to the Swedish mines, with valuable data as to the nature of the ores, methods of working, &c. Serial. Part 1. 2000 w. Engng—Sept. 2, 1898. No. 22714 A.

MINING.

Accidents.

Statistics of Mining Labour and Accidents. A review of the record of mining accidents for 1897, and a discussion of these with reference to the number of persons employed and the nature of the disasters. 2000 w. Col Guard—Sept. 2, 1898. No. 22749 A.

Dangers.

Mining Dangers. Editorial on the points brought out by a special inquiry, made recently, because of the belief that the number of accidents in the Albert district (N. S. W.) was greater than formerly. 1700 w. Engng—Aug. 26, 1898. No. 22569 A.

Explosives.

A Further Contribution to the Subject of Safety Mining Explosives. (Weiteres zur Frage der Sicherheitssprengstoffe.) Bergassesor Heise. A very complete examination of safety explosives, especially as regards chemical composition, and heat evolved during explosion. Four articles. 10,000 w. Glückauf—Aug. 20, 27, Sept. 3, 10, 1898. No. 22959 each B

Kynoch Limited and the High Explosives Trade. An account of the manufactures and experience of this firm, near Birmingham, Eng., with blasting explosives. Ill 3000 w. Ir & Coal Trds Rev—Sept. 16, 1898. No. 22885 A.

The Progress of Explosives. Perry F. Nursey. A comprehensive review of the last report of Col. Sir Vivian D. Magendie, taking up especially accidents and their causes and importations into the United Kingdom. 2000 w. Ind & Ir—Sept. 9, 1898. No. 22664 A.

Fire Damp.

Fire Damp and Underground Meteorology. Emile Harzé. A reply to article entitled "Firedamp in its Relation to Meteorology," published in this paper Aug. 12, considering some of the statements open to criticism. 2800 w. Col Guard—Sept. 16, 1898. No. 22880 A.

Haulage.

Endless Rope Haulage at the Monopol Mine. (Flachscheibenhaspel mit Endlosem Seil auf Zeche Monopol.) An overhead cable hauling system is used, with independent engine; the cars being clamped to the cable. 1200 w. 1 plate. Glückauf—Aug. 13, 1898. No. 22958 B.

Underground Haulage. L. C. Morganroth. A comparison of the methods used in the anthracite mines of Pennsylvania. 2200 w. Mines & Min—Sept., 1898. No. 22482 C.

Mexico.

Mexican Methods of Mining. Describes the modus operandi of a typical Mexican mining company. 1700 w. Min & Sci Pr—Aug. 27, 1898. No. 22473.

Mine Accounts.

Keeping Mine Accounts. A. J. Yungbluth. Read at the Ironwood meeting of the Lake Superior Mining Institute. Discusses general principles, arrangement, grouping, and details. 2800 w. Ir Trd Rev—Sept. 8, 1898. No. 22624.

Mines Drainage.

The South Staffordshire Mines Drainage Scheme. E. B. Marten and Edmund Howe. Read at Birmingham (Eng.) meeting of the Inst. of Mining Engs. The paper deals more especially with the surface, and particularly with the Tipton district, where electric power is to be used. 3000 w. Col Guard—Sept. 16, 1898. No. 22883 A.

Mine Transmission.

Electrical Transmission of Power in the Ziegler Shaft, Nurschan. From a paper by F. Holzner in the *Oesterr. Zeitschr. f Berg-und-Hüttenwesen.* Sections of the workings are given, and illustrations of the various applications of the motors. 2500 w. Col Guard—Sept. 9, 1898. No. 22753 A.

The Electric Power Transmission in the Ziegler Mine at Nürschan. (Die Elektrische Kraftübertragungsanlage am Zieglerschachte bei Nürschan.) Ferdinand Holzner. A very full account of this extensive plant in which electricity is used for pumping, ventilating, hauling, and lighting. Three articles, 5 plates. 5000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Aug. 15, 20, 27, 1898. No. 22961 each B.

Mining Method.

Mining Ore Bodies of Uniform Grade. E. F. Brown. Read at the fifth annual meeting of the Lake Superior Mining Inst. Describes a system of mining in successful operation at the Pewabic mine, Iron Mountain, Mich. 1000 w. Ir Trd Rev—Sept. 1, 1898. No. 22515.

Shaft Fires.

Precautions for Minimizing and Preventing Shaft Fires. Joh. Mayer. From *Oesterreichische Zeitschrift für Berg- und Hüttenwesen.* Considers preventive, remedial, and subsidiary measures. Ill. 1500 w. Col Guard—Sept. 16, 1898. No. 22884 A.

Timber.

On an Improved Appliance for Drawing Timber in Mines. D. H. F. Matthews. Describes the improved appliance known as the Sylvester Pulling Jack. Also discussion. 2000 w. Can Min Rev—Aug., 1898. No. 22592 B.

MISCELLANY.

Aluminum.

Aluminum. A commentary upon its properties, production, and future. 1200 w. Builder—Aug. 27, 1898. No. 22653 A.

Bituminous Rock.

A Bituminous Rock Deposit in Santa Barbara County, California. A. S. Cooper. Illustrated description showing why it is difficult to locate with any great certainty a subterranean reservoir of petroleum. 1500 w. Eng & Min Jour—Sept. 3, 1898. No. 22520.

Brazil.

Explorations in the Lower Amazon District. (Auf der Lagerstättensuche im Unterem Amazonasgebiete.) F. Katzer. A review of the mineral resources of the region, including coal, iron, and gold, by the director of the Pará Museum. 3 articles. 6000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Aug. 6, 13, 20, 1898. No. 22960 each B.

Clay.

Clay. G. J. M. Ashby. A paper read before the Chicago Ceramic Association. Reviews the origin, composition, classification, and uses of clay, and the processes and machinery used in potteries and brick works. 1400 w. Brick—Sept., 1898. No. 22608.

The Clay Resources of Alabama and the Industries Dependent Upon Them. Eugene A. Smith. Brief account of the clays and loams for building brick, material for vitrified brick, kaolins and stone-ware clays and fire-clays. 1200 w. Eng & Min Jour—Sept. 24, 1898. No. 23010.

Corundum.

Corundum in Ontario. An account of the deposits in the vicinity of Hastings and Renfrew, with some analyses and data of concentration tests. 1500 w. Eng & Min Jour—Sept. 10, 1898. No. 22599.

Cuban Minerals.

The Mineral Resources of Cuba. R. Cabrera. A summary of the occurrence and distribution of the deposits of asphaltum, copper, iron, manganese, and gold, with notes on former efforts to develop them. 2500 w. Eng & Min Jour—Sept. 10, 1898. No. 22601.

Exploring.

Magnetic Surveying for Iron Ores. G. Nordenström. A discussion of the various methods of exploring for iron ores by use of the magnetic needle. The Thalén and Tiberg instruments especially are described. 2000 w. Elec Engr, Lond—Sept. 2, 1898. No. 22776 A.

Fire Clays.

Fire Clays. T. C. Hopkins. What they are, where they are found, and how to test them to find their value. The various uses to which they are put and properties necessary for each. Their value in connection with economy in coal mining. Ill. 2800 w. Mines & Min—Sept., 1898. No. 22475 C.

High Temperatures.

A New Method of Treatment of Metals and Alloys, &c. (Ein Neues Verfahren zur Darstellung von Metallen und Legirungen, &c.) Dr. H. Goldschmidt. A discussion of the use of aluminum for obtaining high temperatures in connection with the fusion of metals and other substances. 3000 w. Zeitschr d Ver Deutscher Ing—Sept. 10, 1898. No. 22908 D.

Metallurgical Work.

Between the Mine and the Smelter—A Lecture Delivered Before the Graduating Class of the School of Mines. Albert R. Ledoux. Discusses problems affecting transportation when the smelter is located at a distance from the mine; also the questions of sampling and assaying. 5500 w. Sch of Mines Quar—July, 1898. No. 22430 D.

Michigan Quarries.

The Bayport, Michigan, Quarries. Illustrates and describes these quarries, and reports on the quality of the stone. 2400 w. Stone—Aug., 1898. No. 22259 C.

Mining Boilers.

See Mechanical Engineering, Boilers.

Oil Fields.

The Wyoming Oil Fields. Arthur Lakes. Brief review of what has been done in these fields, and a description of the geology of the Salt Creek fields. 900 w. Mines & Min—Sept., 1898. No. 22483 C.

Ore Deposits.

Swedish Iron Ore Deposits. Hjalmar Lundbohm. A summary of a general report made to the Swedish Board of Trade, and presented at the Stockholm meeting of the Iron and Steel Institute. Sections of the ore beds are given and the results of chemical analyses. 3000 w. Engng—Sept, 9, 1898. No. 22719 A.

Petroleum Accidents.

See Economics and Industry, Miscellany.

Platinum.

The Occurrence of Platinum in the Oural Mountains. R. Helmbacker. Generally descriptive of the several districts, the character of the places, the methods of working, and of the yields, and the occurrence of associated minerals. 4300 w. Min & Sci Pr—Sept. 10, 1898. Serial. 1st part. No. 22679.

Quarrying Ice.

Quarrying Ice in the French Alps. Illustrates and describes the process of cutting and transporting by endless cable, the machinery employed, and the cost and capacity of the plant. 900 w. Ice & Refrig—Sept., 1898. No. 22538 C.

Russia.

A Trip to Russia and the Ural Mountains. George F. Kunz An account of a trip through a rich mineral district, discussing the resources, the finding and working of precious or ornamental stones, the washing for gold and platinum, with notes of general interest. 8500 w. Jour Fr Inst—Sept., 1898. Serial. 1st part. No. 22528 D.

Statistics.

Statistics of Mines and Quarries. A graphical summary of the general report relating to persons employed and accidents in the mines and quarries of the United Kingdom. 5000 w. Ir & Coal Tr Rev—Sept. 2, 1898. No. 22669 A.

Tenancy.

Tenant-for-Life's Power to Work Mines. A legal discussion of the rights of life tenants in connection with the development of mining property. 1200 w. Col Guard—Sept. 2, 1898. No. 22748 A.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Acetylene.

Acetylene from a Hygienic Standpoint. (Acetylen vom Hygienischen Standpunkte.) Josef Vértess. An investigation of the products of combustion of acetylene with especial reference to their effect upon health. Pure acetylene is found very satisfactory in this respect. 2500 w. Gesundheits-Ingenieur — July 31, 1898. No. 22922 B.

A Sober Account of Acetylene. A favorable review of work by William E. Gibbs, entitled "Lighting by Acetylene. Generators, Burners and Electric Furnaces." 1160 w. Jour Gas Lgt—Aug. 23, 1898. No. 22507 A.

Some of the Properties of Acetylene Gas. An abstract translation of a paper read at Paris, by the French engineer Bouvier, which discusses some acetylene accidents and gives interesting data. 1700 w. Sci Am—Sept. 3, 1898. No. 22468.

Address.

Presidential Address at the Meeting of the Eastern Counties Gas Managers' Association, England. W. D. Child. Treating of matters connected with the manufacture and supply of coal gas. 7200 w. Gas Wld—Sept. 17, 1898. No. 22897 A.

Birmingham.

Centenary of Gas-Lighting in Birmingham, Eng. From the Birmingham *Post*. Historical review, giving figures of growth, output, and charges under the corporation. 1300 w. Arch, Lond—Sept. 2, 1898. No. 22651 A.

Gas Engineering.

Wayside Notes. T. S. Cleminshaw. Discusses some questions of interest to gas engineers. 4400 w. Jour of Gas Lgt—Sept. 13, 1898. No. 22847 A.

Incandescent Lighting.

An Afternoon in Ramsgate. Account of an interview with Mr. Valon, engineer to the Ramsgate corporation, chiefly touching incandescent burners, mantles, and gas consumption. 4000 w. Gas Wld—Sept. 3, 1898. No. 22627 A.

High-Pressure Incandescent Gas Lighting. Illustrated description of an automatically-operating compressor using water power. 1500 w. Gas Wld—Sept. 10, 1898. No. 22629 A.

Management of Works.

Waverley Association of Gas Managers: Inaugural Address of President M'Laren, at the Duns meeting in Scotland. Reviewing the special difficulties confronting the small works.

Discussion. 2500 w. Gas Wld—Sept. 10, 1898. No. 22631 A.

Meters.

Experiences with Prepayment Meters. Andrew Wilson. Read before the North British Association of Gas Managers. Describes the introduction and management of over 1000 such meters at Perth; the results were very satisfactory. Discussion. 2200 w. Am Gas Lgt Jour—Sept. 19, 1898. No. 22641.

Testing.

Official Gas Testing. Commenting severely upon the frequent and unexpected changes in methods and standards instituted by the (English) Standards of Light Committee. 1600 w. Jour Gas Lgt—Aug. 30, 1898. No. 22635 A.

Water Gas.

Dr. Bunte's Comments on Water Gas. Comments called forth by published papers by Dr. Strache and Dr. Leybold. 1600 w. Jour of Gas Lgt—Sept. 13, 1898. No. 22846 A.

Dr. Strache's Improvements in Lighting by Water Gas. Abstract translation of a paper in the *Journal für Gasbeleuchtung*. The improvement seems to relate to the apparatus for heating the blast. 1400 w. Jour Gas Lgt—Aug. 30, 1898. Serial. 1st part. No. 22636 A.

Oil Heating in Water Gas Manufacture. E. C. Jones. Abstract of a paper read before the Pacific Coast Gas Association, describing a special form of steam heater which is said to be extremely regular and satisfactory. Data of its performance are given. 1400 w. Gas Wld—Sept. 3, 1898. No. 22628 A.

The Chemical Composition and Technical Analysis of Water Gas. Edward H. Earnshaw. Gives the scheme of analysis of water gas, calling special attention to the presence of notable quantities of paraffines other than marsh gas, involving a modification of the methods of analysis commonly in use. 3500 w. Jour Fr Inst—Sept., 1898. No 22526 D.

SEWERAGE.

Assessment.

Liability for Cost of Main Sewers. Review of a decision by Lord Pearson, of the Scottish Courts, upholding the corporation as against a disputing property owner. 1000 w. Arch, Lond—Sept. 2, 1898. No. 22652 A.

Purification.

Progress in Sewage Purification. W. Kaye Parry. Paper before the Royal Institute of Public Health arraigning recent claims to novelty and pointing out early investigations and successes in sewage disposal by clarification and filtration. 2000 w. Builder—Sept. 3, 1898. No. 22658 A.

Purification of Sewage. E. G. Barrow. Read before the Can. Assn. of Stationary Engineers. Refers especially to the general requisites for a proper land-filtration plant, with mention of sewage farming and chemical precipitation. 2300 w. Can Engr—Sept., 1898. No. 22697.

Sewage Purification by Intermittent Filtration at Central Falls, R. I. Description with plan. 1000 w. Eng News—Sept. 1, 1898. No. 22459.

Sewage Disposal.

Cambridge Sewerage Works. James H. Fuertes. Illustrated description of an English disposal system where lime is added to sewage and the latter filtered a few minutes later. 1000 w. Eng Rec—Sept. 3, 1898. No. 22533.

Sewage Sludges.

Recent Advances in the Bacterio-Chemical Study of Sewage and Polluted Waters. W. E. Adeney. Read before the Inst. of Civ. Engs. of Ireland. Discusses how these matters can be treated so as to prevent after putrefaction being set up in them. 3000 w. Engng—Aug. 26, 1898. No. 22571 A.

Sewer Pipes.

European Methods of Testing Sewer Pipes of Cement and Clay. A review of the preliminary report of M. Gary to the International Association for Testing Materials. Data concerning Continental practice are given. 1000 w. Eng News—Sept. 8, 1898. No. 22723.

Surface Drainage.

Damages for Inadequate Sewerage Works. Review of decisions of Supreme Courts of New York and Delaware concerning a city's responsibility for sewers too small to remove heavy rainfalls. 1100 w. Eng Rec—Sept. 3, 1898. No. 22531.

Ventilation.

Sanitary Excess. Wm. Watson. Strongly condemns the "American system" of interception traps on house drains, and cites Bradford, England, as an example of meeting successfully very difficult conditions. 2300 w. Can Engr—Sept., 1898. No. 22698.

STREETS AND PAVEMENTS.

Asphalt.

The Work of the Brooklyn Asphalt Laboratory. An account of the results of the work of Mr. G. W. Tillson in investigating the chemical nature of paving asphalts used in Brooklyn. 2000 w. Eng Rec—Sept. 17, 1898. No. 22742.

Pavements.

Defects of Creosoted Wood Block Pavements. F. A. Hetherington. Describes the experience in Indianapolis, Ind. The article is answered by Clarence A. Kenyon and Mr. Hetherington replies. Ill. 4200 w. Munic Engng—Sept., 1898. No. 22512 C.

Sidewalks.

Popular Village Sidewalks. Describes the system in operation in Mexico, N. Y., which has furnished a generous amount of concrete sidewalk pavement, thus greatly improving the town and facilitating pedestrian movement. 500 w. Eng Rec—Sept. 24, 1898. No. 22888.

Stone.

The Building and Road Stones of Massachusetts. C. L. Whittle. Historical commentary and review of the principal deposits and the character of the output. 3200 w. Eng & Min Jour—Sept. 17, 1898. No. 22680.

WATER SUPPLY.

Berlin.

The Water Works of Berlin. Jas. H. Fuertes.

With map showing location of works, also plan of filter beds. 1500 w. Eng Rec—Sept. 10, 1898. No. 22737.

Birmingham.

Birmingham Water Supply from Central Wales. An account of the water-supply works for Birmingham, England, by which the water of several streams in Central Wales is to be delivered to the city by gravity through an aqueduct over seventy miles long. Map, profile, and sections of aqueduct are given. 2000 w. Engr, Lond—Sept. 9, 1898. No. 22700 A.

Buffalo.

History of the Buffalo Water Works. Abstract of a paper prepared by Edward B. Guthrie, giving an account of the growth of one of the largest plants in the United States. 2800 w. Eng Rec—Sept. 24, 1898. No. 22894.

Drinking Water.

Drinking Water at Camp Thomas. P. A. Maignen. Discussion of the attempts made to purify the water, with suggestions of treatment necessary to produce a safe, agreeable water. 2700 w. Sci Am Sup—Sept. 24, 1898. No. 22839.

East London.

East London Water Supply. Editorial discussion of the cause of the present scarcity of water, and the difficulties with which the company has had to contend. 1600 w. Engr, Lond—Aug. 26, 1898. No. 22576 A.

Pipe Lines.

Old and New Methods Applied in Planning Pipe-Lines and Penstocks. F. M. F. Cazin. Presents a new method, conflicting with prevailing practice, and the reasons and causes why it should be adopted in planning supply-pipes. A question of hydraulics. 5000 w. Jour Fr Inst—Sept., 1898. Serial. 1st part. No. 22527 D.

Purification.

The Purification of Water. Editorial upon the relation of water supply and sources of contamination, discussing the various methods of sterilization and purification for drinking water. 1500 w. Engr, Lond—Sept. 9, 1898. No. 22703 A.

The Purification of Drinking Water. Henry E. P. Cottrell. An account of the experience in France and the late progress made there in water purification is given in part first. 1800 w. Engng—Aug. 26, 1898. Serial. 1st part. No. 22564 A.

Water Purification at Wilmington, Delaware. Illustrated description of filtration plant of a rated capacity of 10,000,000 gallons per day. The upward flow system is used. 3000 w. Eng News—Sept. 8, 1898. No. 22721.

Rome.

The Water Supply of Rome. Jas. H. Fuertes. A description of the ancient and modern aqueducts, with map, showing the sources of Roman water supplies. 1800 w. Eng Rec—Sept. 17, 1898. No. 22743.

Simla.

The Simla Water Works. An account, by Chas. E. V. Goument of the plant for the very varying demands of this summer resort of India. 3000 w. Eng Rec—Sept. 10, 1898. No. 22738.

Standpipe.

Racine's Standpipe and its Brick Casing. Read before the Am. W. W. Association. Describes the construction of the pipe and the means used in dealing with ice. 700 w. Am Arch—Sept. 17, 1898. No. 22676.

Tube Wells.

Tube Well Experiments at Lowell, Mass. George Bowers. From a paper presented at the Portsmouth meeting of the New Eng. Water-Works Assn. Describes the results obtained with the third set of tube wells sunk for the water-works of Lowell. 1500 w. Eng Rec—Sept. 24, 1898. No. 22893.

Vienna.

The Vienna High-Service Water Works. (Das Wasserwerk der Wiener Hochquellenleitung.) Franz Borkowitz. An illustrated account of the Breitensee division of the Vienna water supply, with profile, plan of works, and section of the covered reservoir. 2000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—Aug. 19, 1898. No. 22910 B.

Water Famine.

The Dry Weather and the Water Supply. Account of an inspection of the East London Water Company's reservoirs, detailing the effect of drought on the river Lea. 12,000 w. Jour Gas Lgt—Sept. 6, 1898. No. 22636 A.

Water Meters.

The Results of the Meter System in Atlanta, Ga. Statement of the president of the water board concerning saving in coal for pumping and improvement in fire-protection resulting from universal use of meters. 800 w. Eng Rec—Sept. 3, 1898. No. 22535.

Water-Works.

The Steubenville, Ohio, Water-Works. Illustrates and describes the new plant in use since 1895. 2000 w. Eng Rec—Sept. 24, 1898. No. 22892.

MISCELLANY.

Destructors.

Refuse Destruction at Edinburgh. An illustrated account of the station and its equipment, the present condition and the history. 2800 w. Engr, Lond—Aug. 26, 1898. No. 22575 A.

Refuse Destructors. F. L. Watson. A paper upon the designing and construction of refuse destructors, with descriptions of the most important forms used in the United Kingdom. 2000 w. Engng—Sept. 9, 1898. No. 22720 A.

Fire Protection.

American Fire Protection. Summary of a report by Sir D. Colnaghi describing the organization and equipment of the Boston, Mass., fire department. 1500 w. Arch, Lond—Sept. 2, 1898. No. 22649 A.

Franchise Rights.

Remuneration to Cities for Franchise Rights. T. S. McMurray. Read at the Detroit meeting

of the League of American Municipalities. Believes in municipal control of all public utilities, but as this must come gradually favors the paying of a fair remuneration for these rights. Discusses the problem. Also general discussion. 4500 w. Pro Age—Sept. 1, 1898. No. 22488.

Playgrounds.

Municipal Playgrounds in Chicago. Charles Zueblin. Reviews the experience of two months in these playgrounds, the difficulties, the success, and the needs of the future. Ill. 3000 w. Am Jour of Soc—Sept., 1898. No. 22792 D.

The Movement for Small Playgrounds. Sadie American. Reports the benefits derived from the establishment of playgrounds and outdoor gymnasiums, describing those established in various places. 4500 w. Am Jour of Soc—Sept., 1898. No. 22793 D.

Public Health.

Congress of the Royal Institute of Public Health. Report of the presidential and other addresses dealing with subsoils, nuisances, sewage disposal, sanitation, and kindred topics. 5000 w. Builder—Aug. 27, 1898. No. 22654 A.

Trading.

Municipal Trading. Abstracts of papers discussing the subject of the limits of municipal trading in the Section of Economic Science and Statistics, at the meeting of the British Assn. 2300 w. Arch, Lond—Sept. 16, 1898. No. 22898 A.

RAILWAY AFFAIRS.

CONDUCTING TRANSPORTATION.

Accident.

The Wellingborough Accident. Illustrated account of an accident on an English railway. 900 w. Engng—Sept. 16, 1898. No. 22872 A.

Train Accidents in the United States in July. A brief description of each, with classified summary. 4000 w. R R Gaz—Sept. 9, 1898. No. 22617.

Fast Runs.

The Two Fastest Long Distance Runs Without Stop. An account of the locomotive performance of the Empire State Express of the N. Y. C. & H. R. R. R. and the Cornish Express of the Great Western Railway, England. Ill. 2500 w. Sci Am—Sept. 3, 1898. No. 22469.

Firemen.

Instructing Firemen. Editorial calling attention to some things firemen should be taught, and referring to the discussion to be held at the convention of the Traveling Engs. Assn. on "How can the traveling engineer best instruct and assist firemen in the economical firing of locomotives?" 1000 w. Loc Engng—Sept., 1898. No. 22551 C.

Military Railways.

The Working of Railways in Military Operations. W. L. Derr. A discussion of the need for greater knowledge and experience in railroading in military operations, commenting on the manner in which the subject has hitherto been neglected by army officials, and suggesting lines upon which it should be developed. 3500 w. Engineering Magazine — October, 1898. No. 22996 B.

New Zealand.

New Zealand Railways. Editorial criticism on the management of these state railways. 1200 w. Engng—Sept. 16, 1898. No. 22875 A.

Signalling.

Some Elementary Notions about Signals. A statement and exposition of four desirable ideals, not incompatible with the restrictions which frequently surround a small or impoverished road. 2000 w. R R Gaz—Sept. 9, 1898. No. 22619.

Statistics.

Statistics of Railways in the United States for the year ending June 30, 1898. Extracts from the advance abstract of the tenth annual report furnished by Henry C. Adams. 1500 w. Eng News—Sept. 1, 1898. No 22466.

FINANCIAL.

Earnings.

Hopeful Railroad Earnings Returns. Reports the very satisfactory conditions for the month of August, with the prospects of even more favorable conditions for the future. 1800 w. Bradstreet's—Sept. 17, 1898. No. 22803.

LEGAL.

Light Railways.

An English Light Railway. A discussion of the principal clauses of the charter of the Crowland & District Light Railway, showing how the very strict regulations as to railroad building have been relaxed to permit construction where a standard railroad would be unprofitable. 2200 w. R R Gaz—Sept. 9, 1898. No. 22616.

State Regulation.

State Regulation of Railroads in Great Britain. Editorial on the Fishguard scheme and the action of the British Parliament. 1200 w. R R Gaz—Sept. 23, 1898. No. 22865.

Swiss Railroads.

The Nationalization of the Railroads in Switzerland. M. Horace Micheli. Gives the history of the railroads in Switzerland and the arguments presented which finally secured the management of the railroads by the state. 4800 w. Ap Pop Sci M—Sept., 1898. No. 22442 D.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Air-Brake Instruction. A report presented by a committee to the sixth annual convention of

the Traveling Engs. Assn. at Buffalo. Suggestions relating to methods to be taught, and points for instruction. 5000 w. Ry Age—Sept. 23, 1898. No. 23005.

Air-Brake Hose.

Specifications for Air-Brake Hose. Synopsis of paper by Arthur M. Waitt, read at convention of Master Car Builders' Assn., with comments of the trade, and by the editor. 4500 w. Ind Rub Wld—Sept. 1, 1898. No. 22433 D.

Brake-Beams.

Mechanics of the Cambered Brake-Beam. Irving P. Church. The object of the paper is to determine the stresses induced in the various members of the brake-beam when employed in pressing the brake-shoes at its extremities against the car-wheels; and also the deflection of the middle point at the same instant. 2500 w. Jour Fr Inst—Sept., 1898. No. 22529 D.

Buffet Car.

A Novelty in Buffet Cars—C. G. W. Ry. Illustrates and describes a decidedly novel and pleasing car recently placed on the Chicago-St. Paul division of this road. 500 w. Ry Mas Mech—Sept., 1898. No. 22554.

Car Heating.

Heating Cars by Steam on the Paris-Lyons-Mediterranean Railway. (Chauffage des Trains par la Vapeur sur le Réseau Paris-Lyons-Mediterranée.) M. Mottet. A general description of the apparatus used, with plates of details of connections, valves, radiators, &c., and diagrams of the results of tests. 4000 w. 4 plates. Rev Gen des Chemins de Fer—Aug., 1898. No. 22942 G.

Car Lighting.

Electric Lighting of English Railroad Trains. The systems which have been tried in Great Britain and on the continent are described, especially the Stone system. 1600 w. R R Gaz—Sept. 16, 1898. No. 22823.

Railway Carriage Lighting by Compressed Oil Gas and Acetylene. Giving an illustrated account of the plant used in Berlin for an oil-gas enriched with acetylene and compressed in tanks for lighting carriages on the Prussian State Railways. 1000 w. Engr, Lond—Sept. 9, 1898. No. 22704 A.

Coal Car.

Double Hopper-Bottom Coal Car, 100,000 lbs. Capacity, Northern Pacific Railroad. Elevation, plan, sections and truck, with description. 600 w. Ry & Engng Rev—Sept. 10, 1898. No. 22825.

Headlights.

Searchlight Attachment for Headlights. Brief illustrated description of a simple arrangement, devised by John S. Thurman, for enabling the engineer to adjust his headlight on the searchlight principle. 300 w. Ry Age—Sept. 16, 1898. No. 22824.

Ladle Car.

A Car for Carrying Molten Metal. Brief illustrated description of a car used by the Carnegie Steel Co. 300 w. Ry Age—Sept. 23, 1898. No. 23004.

Locomotive Boiler.

See Mechanical Engineering, Boilers.

Locomotives.

Consolidation Locomotives—Burlington & Missouri River Railroad. Illustrated description of engines for freight service in the Black Hills. 350 w. Am Eng & R R Jour—Sept., 1898. No. 22456 C.

Four-Cylinder Express Locomotive. Illustrated description of a powerful English engine, designed by Dugald Drummond, of the London & South-Western Ry., with profile graphically recording its performance, and a set of indicator diagrams. 450 w. Engr, Lond—Aug. 26, 1898. No. 22578 A.

Narrow Gauge Locomotive, Soudan Railway. Illustration and brief description, also showing the method of transporting a gun boat in sections over the narrow gauge Soudan Railway. 200 w. Engr, Lond—Sept. 2, 1898. No. 22707 A.

New Mogul Locomotives of the Chicago Great Western Railway. Illustrated description, general dimensions and special equipment of two freight locomotives recently put on this road. 1200 w. R R Gaz—Sept. 23, 1898. No. 22864.

Peculiar Locomotives. Illustrated description of two old locomotives on the Pacific coast, the property of the Oakland Nail Works. 600 w. Loc Engng—Sept., 1898. No. 22549 C.

Rogers Locomotive Company Compound System. Illustrated description of this system of compounding locomotives. 1300 w. Loc Engng—Sept., 1898. No. 22552 C.

The New Express Locomotives of the French State Railways. (Les Nouvelles Machines d'Express du Réseau de l'Etat Français.) With illustrations of the four-cylinder compound engines, and of the simple express engines recently put into service. 1800 w. La Revue Technique—Aug. 25, 1898. No. 22934 D.

The New Great Northern Engines and Their Work. Charles Rous-Marten. Introductory remarks on the changed conditions which make necessary more powerful engines, with information concerning the engines designed by H. A. Watt, especially No. 990, giving the results of these journeys illustrative of its working. 3800 w. Engr, Lond—Aug. 26, 1898. No. 22574 A.

Locomotive Works.

See Mechanical Engineering, Compressed Air.

Trucks.

Metal Trucks for Freight Cars. Giving descriptions of the principal varieties used in the United States, with editorial upon the general advantages of metal over wood for trucks. 5000 w. Eng News—Sept. 15, 1898. No. 22728.

Swivel Trucks Used on American Cars. (Trucks Articulés de Voitures et de Wagons Usités aux Etats-Unis). M. Demoulin. A general account of the various trucks used in the United States, especially in comparison with the rigid axles of European practice. 7500 w. 4 plates. Rev Gen des Chemins de Fer—Aug., 1898. No. 22941 G.

NEW PROJECTS.

Alaska.

The First Railway to the Alaska Gold Fields. Illustrations showing some of the difficulties encountered in building the road from Skagway, Alaska, via the White Pass to Fort Selkirk, N. W. T., a distance of 380 miles. 600 w. Ry Age—Sept. 2, 1898. No. 22546.

Aviemore Railway.

The Aviemore Railway. Description of the constructional and scenic features of the line, which has been under construction for seven years and is just about to be opened for traffic. 1600 w. Arch, Lond—Sept. 2, 1898. No. 22649 A.

Central London.

The Central London Railway. A review of the traffic relations of the line, its general characteristics, and equipment. 2000 w. Br Arch—Sept. 2, 1898. No. 22661 A.

Ceylon.

Ceylon Railway Extensions. Comments upon the severe engineering difficulties often met in India, and briefly summarizes the climatic and topographic obstacles encountered in certain cases. Ind Engng—Aug. 13, 1898. No. 22802 D.

China.

American Contract for a Railroad in China. Brief account of road to be built from Han Kow to Canton. Map. 500 w. R R Gaz—Sept. 23, 1898. No. 22863.

Railways in China. Editorial on the recent developments and importance of the railway question in China, calling attention to the present position of the British government. 1800 w. Engng—Aug. 26, 1898. No. 22568 A.

Congo.

The Congo Railroad. From *L'Illustration*. Particulars concerning this railway, its route, construction and great importance. 2500 w. Sci Am Sup—Sept. 24, 1898. No. 22838.

Cripple Creek, Colo.

The Railways of the Cripple Creek, Colo., Mining District. W. P. Hardesty. Gives brief descriptions of the various railways, both steam and electric, as well as views of various portions, and a topographical map of the region. 2000 w. Eng News—Sept. 8. 1898. No. 22725.

East Africa.

Railway Construction in German East Africa. From a lecture delivered by Mr. Bernhard before the Bergischer Bezirksverein, translated and published in the Bulletin of the International Railway Congress. The territory is four-fifths as large as Germany, and contains four million inhabitants. An account is given of the work thus far projected or constructed toward providing better means of transportation, with some account of the difficulties. 1700 w. Ry & Engng Rev—Sept. 3, 1898. No. 22555.

Korea.

The First Railway in Korea. Interesting particulars of the railway being built by the Seoul & Chemulpo Ry Co. 600 w. Eng News—Sept. 1, 1898. No. 22460.

Mallaig Railway.

The Mallaig Railway. An illustrated account of this railway, being constructed in the Scottish Highlands, which, from a scenic and historical point of view, will be almost unrivalled. 3300 w. Engr, Lond—Sept. 16, 1898. No. 22878 A.

Rack Railway.

The Nilgiri Rack Railway. A plan and section, with four views of the first rack railway in India, now nearly completed. Brief description. 700 w. Engng—Sept. 16, 1898. No. 22871 A.

Siberian Railroad.

Quinquennial Report of the Committee for Building the Siberian Railroad. Translated from the *Zeitung Der Vereins Deutschen Eisenbahn-Verwaltungen*. Reports the work accomplished, the work under way, and to be undertaken. 1500 w. R R Gaz—Sept. 16, 1898. No. 22822.

Simplon.

The Simplon Undertaking. (L'Entreprise du Simplon.) An account of the work involved in the construction of a railway across the Simplon Pass, including the Simplon tunnel of over 12 miles long. The total outlay is to be 70,000,000 francs. 1500 w. Moniteur Industriel—Sept. 10, 1898. No. 22943 G.

South Africa.

Railroad Building in South Africa. Summary of the existing and proposed railways in the Orange Free State, South African Republic, and Rhodesia, with map and quotation from report of Gen'l Mgr. of Rail Roads of the Cape of Good Hope referring to the Bechuanaland R.R. 800 w. R R Gaz—Sept 9, 1898. No. 22614.

Underground Railroad.

The Waterloo and City Railway, London. W. B. Paley. A general description of the tunnels, lighting, equipment and train movement. 1000 w. R R Gaz—Sept. 9, 1898. No. 22615.

U. S. Railroad.

Nearly 1,300 Miles of New Road in the First Half of 1898. Revised report giving figures in detail by States. 1400 w. R R Gaz—Sept. 2, 1898. No. 22524.

PERMANENT WAY AND FIXTURES.

Africa.

The Railways of Africa. (Die Afrikanischen Eisenbahnen.) With map, showing the existing roads and proposed constructions. 1500 w. Stahl und Eisen—Sept. 1, 1898. No. 22957 D.

Chili.

The Taltal Railway. (Die Taltalbahn.) Deodoro Moegle. An account of this Chilian railway, extending from Taltal on the coast, to Cachinal, at an elevation of over 9000 feet in the Andes. The road affords an outlet for saltpetre, as well as gold, silver, and copper to the coast. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 26, 1898. No. 22913 B.

Embankments.

On Saving and Stopping Slips. Showing the

cause of landslips to be the presence of water; tracing the different ways in which it may attack a bank, and indicating the effective methods of preventing it by drainage. 2700 w. Ill. Ind & East Engr—Aug., 1898. No. 22687 D.

Freight Yard.

Harlem Transfer Co's. Freight Yard, New York City. Plan and data relating to this novel freight yard, designed by Walter C. Berg. 900 w. Ry & Engng Rev—Sept. 24, 1898. No. 23053.

Grade Crossings.

Abolition of the Grade Crossings on the Main Line of the Boston and Albany Railroad in Newton, Mass. I. History of the improvement, and an account of the street and drainage work connected therewith; by Irving T. Farnham. II. The depression of the railroad tracks; by William Parker. III. Bridges over the railroad tracks; by W. G. S. Chamberlin. Ill. 11800 w. Jour Assn of Engng Soc—Aug., 1898. No. 22844 C.

Steam and Electric Railway Crossings. An editorial based upon the accident at Cohoes, N. Y., showing the importance of adequate mechanical protection, and suggesting an interlocking system, with derailing device for the electric line. 800 w. Ry & Eng Rev—Sept. 24, 1898. No. 23150.

Rails.

Advisability of Increasing Length of Rails and Advantages to be Derived from Use of Rails with Mitre-cut Ends. From a report by R. Caffrey, presented at the convention of the Roadmasters' Assn. of America. 2500 w. Ry & Engng Rev—Sept. 17, 1898. No. 22831.

The Danger of Using Too Hard Steel Rails. C. P. Sandberg. A paper before the Iron & Steel Institute showing the danger of fracture with too hard steel, especially in cold climates. 2000 w. Engr, Lond—Sept. 2, 1898. No. 22708 A.

R. R. Water Supply.

Locomotive Water Supply. Theodore W. Snow. Discusses tank fixtures, standpipes and track tanks. Also general discussion by Mr. Thomas Appleton. Ill. 2500 w. Jour of W Soc of Engs—Aug., 1898. No. 22794 D.

Reservoir.

A Storage Reservoir for a Railroad Water Station. Augustus Torrey. Describes a novel plan used in constructing a waste weir. 1000 w. Jour of W Soc of Engs—Aug., 1898. No. 22795 D.

Signal Poles.

Iron Signal Poles on the C. M. & St. P. Ry. Illustrated description. 1000 w. Am Eng & R R Jour—Sept., 1898. No. 22455 C.

Signals.

Improvements in French Block Systems (Neuerungen in Französischen Blocksysteme.) Oskar Walzel. A review of the improved signal system recently installed on the Northern Railway of France. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 19, 1898. No. 22912 B.

The Bouré System of Interlocking Signals. (Les Enclenchements par Serrures, Systeme Bouré). F. l'Heureux. Especially adapted to be used at small stations where a complete signal tower is not required. 5000 w. 3 plates. Revue Universelle des Mines—Aug., 1898. No. 22945 H.

Stations.

Great Railway Stations of England. Thomas Cargill. A very fully illustrated account of the principal railway terminals with plans of track arrangements, and details of design and construction of buildings. The first of a series of three papers. 4500 w. Engineering Magazine—October, 1898. No. 22997 B.

New Goods Station, Great Northern Railway, Manchester. Illustrated account of the new station, now under construction, with plans of the complete structure and photographs of the present condition of the works. 2000 w. Engr, Lond—Sept. 2, 1898. No. 22706 A.

The New Dresden Main Station. Illustrated description of a new building, said to be one of the finest of its kind in Europe. 1500 w. R R Gaz—Sept. 9, 1898. No. 22618.

Tie Plates.

Tie Plates. Extracts from an interesting report presented at the Denver convention of the Road Masters' Assn. of America. 2200 w. R R Gaz—Sept. 23, 1898. No. 22862.

Ties.

Tie Preservation in the Southwest. Information on the operation and development of the preservation plant at Somerville, Tex., with some of the results of the zinc-chloride process on ties laid thirteen years ago. Ill. 1100 w. Ry & Engng Rev—Sept. 10, 1898. No. 22827.

Track.

Track Construction. D. F. Carver. A paper before the N. Y. Street Railway Assn., giving the writer's views, especially as to substructure for street railway track. 2000 w. St Ry Rev—Sept. 15, 1898. No. 22861 C.

Track Construction in the Far East. Brief illustrated description of peculiar methods. 700 w. Ry & Engng Rev—Sept. 10, 1898. No. 22828.

TRAFFIC.

Rates.

Canadian Pacific Passenger Rate Differentials. Synopsis of the decision of the Interstate Commerce Commission, with editorial. 2800 w. Ry & Engng Rev—Sept. 10, 1898. No. 22829.

The Canadian Pacific Decision. Editorial upholding the soundness of the recent decision of the Interstate Commerce Commission. 800 w. Bradstreet's—Sept. 10, 1898. No. 22602.

The Reduction in Railway Transportation Rates in the United States. Editorial comment on a special report recently published by the Division of Statistics of the Dept. of Agriculture giving the decrease in railway passenger and freight rates, and the means by which this reduction has been brought about. 1800 w. Eng News—Sept. 1, 1898. No. 22462.

STREET AND ELECTRIC TRAMWAYS.

Accounting.

Report on Standard System of Street Railway Accounting. Report of the committee appointed at the Niagara Falls convention. 18,000 w. St Ry Rev—Sept. 15, 1898. No. 22855 C.

Accumulator Traction.

Present Position of Accumulator Traction. M. Van Loenen-Martinet. A report read at the meeting of the Permanent International Tramways Union, held at Geneva, upon the question: "What progress has been made in accumulator traction?" 1700 w. Ry Wld—Sept. 8, 1898. No. 22869 A.

Australian Tramway.

Tramway System of Brisbane, Australia. S. Herbert Brown. Gives an account of the change from the horse to the electric system, the extension of lines and the success met with. Ill. 1800 w. St Ry Jour—Sept., 1898. No. 22502 D.

Bahia.

The Electric Street Tramway in Bahia. (Die Elektrische Strassenbahn in Bahia.) Gustav Braun. An illustrated account of this Brazilian road, with map showing the route along the coast from Bahia to Itapagipe. 2000 w. Elektrotech Zeitschr—Sept. 8, 1898. No. 22979 B.

Bonds.

Rail Bonds. Calls attention to points learned by experience, and gives illustrated description of the mechanical features of many types. 4000 w. St Ry Jour—Sept., 1898. No. 22499 D.

Track Bonding. R. P. Brown and G. E. Chapin. Report of committee to the N. Y. State St. Ry. Assn., discussing the various kinds of rail bonds for electric return currents and comparing the independent bonds with the continuous welded rail. 2300 w. St Ry Rev—Sept. 15, 1898. No. 22859 C.

Boston Elevated.

The Harvard Power Station of the Boston Elevated Railway Company. H. W. Weller. Illustrated description of this new power house, including the present plant and the plans for future extension. 2500 w. Elec Engr, N. Y.—Sept. 8, 1898. No. 22754.

The Proposed New Electric Elevated Railway in Boston. Gives a brief description of the new elevated railway system as at present planned, with a statement of the difficulties of the problem. Ill. 1200 w. St Ry Jour—Sept., 1898. No. 22495 D.

Boston Street Railways.

Street Railway Conditions and Financial Results in Metropolitan Boston. Illustrated description of the principal investment, traffic and operating characteristics of thirty-nine street railways located in the city of Boston, and in about seventy-five suburban cities and towns in the immediate neighborhood. 13,800 w. St Ry Jour—Sept., 1898. No. 22493 D.

Boston Subway.

The Boston Subway. Brief history and illustrated description of this very successful engineering work, giving information concerning traffic, platforms and stations, construction and equipment, and cost. 5000 w. St Ry Jour—Sept., 1898. No. 22494 D.

Bradford.

Bradford Corporation Electric Tramways. An illustrated account of the plant recently installed at Bradford, England, noteworthy as being owned and operated by the municipality. 2000 w. Elec Engr, Lond—Aug. 26, 1898. No. 22773 A.

Budapest.

The Electric Underground Railway at Budapest. (Le Chemin de Fer Electrique Souterrain de Budapest.) P. Crépy. Description, with photographs of stations and views of the cars, trucks, boilers and engines. 2000 w. 1 plate. La Revue Technique—Aug 10, 1898. No. 22332 D.

By-Products.

By-Products of the Power House. M. M. Fenner. Read at meeting of the N. Y. State St. Ry. Assn. The writer's experience for four years in the utilization of exhaust steam. Discussion. 5000 w. St Ry Rev—Sept. 15, 1898. No. 22858 C.

Car Mileage.

Car Mileage—How Arrived at, and Its Use. A. H. Ford. Read before the St. Ry. Accountant's Assn. of America. Explains briefly its use and how arrived at, giving copies of some of the forms used. 500 w. St Ry Rev—Sept. 15, 1898. No. 22854 C.

Central Stations.

Central Station Economics. William D. Ennis. Part first discusses the operative economies of an electric railroad power station, especially considering the improvements in mechanical apparatus. 2700 w. R R Gaz—Sept. 2, 1898. Serial. 1st part. No. 22521.

Changed Power.

Conversion of the Edinburgh Horse Tramway System into Cable Traction. W. N. Colam. States the conditions under which these lines have been compelled to operate, and shows that though they are unfavorable the results have been very satisfactory. Gives reasons for adopting the cable system, and description. 5300 w. St Ry Jour—Sept., 1898. No. 22505 D.

Steam Railroad Conversion Near Lockport. Illustrates and describes the change made on a branch line of the Erie Railroad, running from Tonawanda to Lockport, N. Y. The service of a mixed type, the passenger traffic being carried on by trolley cars, and the freight service by electric locomotives. 3000 w. St Ry Jour—Sept., 1898., No. 22503 D.

Economy.

Economizing Electrical Power. E. G. Connette. Reports the improvement in consumption of power on the Nashville Street Railway

since it has been running on the meter system, giving the rules issued and the suggestions for economical application of the current. 2000 w. St Ry Jour—Sept., 1898. No. 22497 D.

Electric Cars.

Equipment and Maintenance of Electric Cars. M. S. Hopkins. Read before the A. S. R. A. Gives the results of extended experience. 6800 w. St Ry Rev—Sept. 15, 1898. No. 22851 C.

Electric Construction.

Recent Electric Construction of the New York, New Haven & Hartford Railroad Company. N. H. Heft. A report of the recent extensions of this system, and the changes made in the rolling stock. Ill. 1600 w. St Ry Jour—Sept., 1898. No. 22504 D.

Electric Locomotive.

The Substitution of Electricity in Place of Steam on a Branch of the Erie R. R. Two 36 ton electric locomotives, of 640 h. p. each are used to haul freight and passenger traffic over 20 miles of track. The overhead trolley system is employed. 1200 w. Eng News—Sept. 8, 1898. No. 22726.

Electric Railway.

The Buffalo and Lockport Electric Railway. Illustrated description of this railway operated by Niagara power for both freight and passenger traffic. 1500 w. Elec Engr, N. Y.—Sept. 8, 1898. No. 22756.

English Tramways.

English Electric Railroads. A statement of the general situation in England with notes on a few of the roads recently completed. Ill. 2800 w. R R Gaz—Sept. 2, 1898. Serial. 1st part. No. 22522.

Inspection.

Herrick's Electric Car Inspection System. A complete portable testing set of instruments is provided, enabling systematic inspection to be carried out at any point on the line. 1500 w. Elec Engr, N. Y.—Sept. 8, 1898. No. 22755.

Inspection and Testing of Motors and Car Equipments by Street Railway Companies. Frederick B. Perkins. Read before the A. S. R.A. Discusses the care of electrical equipment and the system of inspection. 4500 w. St Ry Rev—Sept. 15, 1898. No. 22852 C.

Light Railways.

The North Sunderland Light Railway. Brief illustrated description. 1200 w. Transport—Aug. 26, 1898. No. 22593 A.

Mail Carrying.

The Carrying of U. S. Mail Matter on Interurban and Street Railways. W. S. Dimmock. Read before the A. S. R. A. Showing the gain to the Post Office Department from the use of electric lines. Discussion. 6300 w. St Ry Rev—Sept. 15, 1898. No. 22850 C.

Motive Power.

Possible Future Motive Power for Tramways. W. H. Booth. Discusses the possibility of using blast-furnace gases by putting down gas engines and dynamos, and manufacturing electricity. 2200 w. Ry Wld—Sept. 8, 1898. No. 22506 A.

Motor Truck.

New Motor Truck for the Lake Street Elevated, Chicago. Illustrates and describes a design by Frank Hedley. The construction is simple, with a large clear space for the motors. 400 w. R R Gaz—Sept. 16, 1898. No. 22821.

Norway.

The Holmenkollen Railway. (Die Holmenkollen-Bahn.) F. Hoffman. A very complete account of this electric road, running from Christiania to Holmenkollen, with map and many views, and plans of the wiring and station accumulators. 6000 w. Elektrotech Zeitschr—Sept. 1, 1898. No. 22974 B.

Paris.

Dual Electric System in Paris. A detailed description of this installation for dual or mixed traction, constructed by the French Thomson-Houston Co. Ill. 1700 w. Ry Wld—Sept. 8, 1898. No. 22867 A.

Power Consumption.

Power Consumption on Electric Railroads. S. T. Dodd. Read before the Civil Engs.' Club of Cleveland. Analyzes train resistances under the divisions of grade curve, acceleration and frictional resistances, and illustrates the data by problems. Also discussion. 5000 w. Jour Assn of Engng Soc's—Aug., 1898. No. 22845 C.

Power Cost.

Cost of Electric Power for Street Railways at the Switchboard, both Steam and Water Power. R. W. Conant. Read before the A. S. R. A. Facts and figures bearing on the operation of 44 power stations located at important centres throughout the United States are discussed. Discussion. 7500 w. St Ry Rev—Sept. 15, 1898. No. 22853 C.

Power Plant.

Long Distance Transmission Power Plant, Montpelier, Vt., with Battery Auxiliary. Illustrates and describes the new plant of the Barre-Montpelier Traction and Power Co., which presents some very interesting features. 500 w. St Ry Jour—Sept., 1898. No. 22501 D.

New Power Plant at Akron, Ohio. Illustrated detailed description of a first-class plant. 1500 w. St Ry Jour—Sept., 1898. No. 22500 D.

Power Stations.

Temporary Power Stations of the Metropolitan Street Railway Company. A description of the two substantial temporary power houses of the New York Metropolitan Railway, with illustrations of Switchboards and automatic stokers. 1800 w. Elec Wld—Sept. 10, 1898. No. 22764.

Rails.

Rails; Their Construction from a Scientific Standpoint. A. J. Moxham. Read at meeting of the N. Y. State St. Ry. Assn. Reports experiments conducted by the Lorain Steel Co., and the conclusions reached. 3300 w. St Ry Rev—Sept. 15, 1898. No. 22860 C.

Signal System.

Signal System for Single Track Roads. H. S. Cooper. Read at meeting of the N. Y State St. Ry. Assn. Considers the characteristics of

a reliable signal system. Discussion. 3500 w. St Ry Rev—Sept. 15, 1898. No. 22857 C.

Suggestions.

Some Suggestions to European Electric Railway Builders. Some points of importance regarding roadbed, track special work, power stations, equipment, &c. 1200 w. St Ry Jour—Sept., 1898. No. 22496 D.

Traction.

Electric Traction. Charles A. Carus-Wilson. A discussion of some of the principles connected with the application of the direct current motor to electric traction. Ill. 5000 w. Jour Soc of Arts—Sept. 16, 1898. Serial. 1st lecture. No. 23016 A.

Electric Traction on the Wannsee Railway. (Ueber die Elektrische Zugförderung auf der Wannseebahn.) A paper by Director Bork before the German Railway Society, with detail accounts of the operation of the section of road between Berlin and Zehlendorf by electricity. Data of construction, operation and cost for the past year are given. 6000 w. 1 plate. Glaser's Annalen—Aug. 15, 1898. No. 22920 D.

Heavy Electric Traction, Buffalo & Lockport Ry. Particulars of the most recent application of electricity to the steam railroad, in the United States, with illustrations. 2000 w. Ry & Engng Rev—Sept. 10, 1898. No. 22826.

Legal Aspects of Electric Street Traction in England. E. F. Vesey Knox. An exposition of the necessity for more extended use of electric traction in England, together with an account of the political difficulties which obstruct the efforts to meet the demand. 5000 w. Engineering Magazine—October, 1898. No. 22993 B.

Notes on Traction by Electric Power. A. C. Elliott. A paper setting forth the advantages of electric power for traction, and urging its wider extension to heavy traffic. 2500 w. Elec Engr, Lond—Aug. 26, 1898. No. 22774 A.

Traffic.

Methods of Developing New Traffic on Street Railways. H. M. Kennedy. Read at meeting of the N. Y. State St. Ry. Assn. Discusses some of the methods that have proved successful. General discussion. 7500 w. St Ry Rev—Sept. 15, 1898. No. 22586 C.

Tramway System.

Kingsland Electric Tramway System. Illustrates and describes an improved surface-rail system. 2000 w. Engng—Aug. 26, 1898. No. 22570 A.

Tramway.

The Blackpool and Fleetwood Electric Tramroad. Illustrated detailed description of the road and its equipment. 4000 w. Ry Wld—Sept. 8, 1898. No. 22866 A.

Transmission.

Air vs. Electricity in Long Distance Transmission. W. S. Norman. From British Columbia *Mining Record*. Aiming to show that for the uses of a mining camp, compressed air under the Taylor system is cheaper in its first cost of installation and much cheaper in operation in comparison with electric power. 1 4000 w. Compressed Air—Sept., 1898. No. 22492.

Truck.

A Passenger Locomotive Truck. Illustrates and describes a truck built by the J. G. Br Co., of Phila., to carry an electric passenger locomotive which shall not only haul a train b carry passengers. 1800 w. Ry Wld—Sept. 1898. No. 22868 A.

Comparative Earnings and Economy of Operation Between Single and Double Truck Cars for City Use. Richard McCulloch. Read at the Boston convention of the A. S. R. A. Gives comparison of power required and weights carried and shows the advantages and disadvantages of each type. With discussion. Ill. 5800 w. St Ry Rev—Sept. 15, 1898. No. 22849 C.

Underground.

Arrangement of Underground Electric Tramways. (Dispositif Electrique Souterrain pour la Traction des Tramways.) Ch. Gruet. Describes an improved underground trolley system on the separate contact principle. 2000 w. La Revue Technique—Sept. 10, 1898. No. 22939.

The Construction of Electric Tramways with Underground Conduits. (Construction des Lignes de Tramways Electrique à Caniveau Souterrain.) A general discussion of the constructive features of the problem, with sections of various forms of conduits for underground trolleys. 2500 w. L'Electricien—Aug. 6, 1898. No. 22963 B.

BOOKS OF THE MONTH

A LABORATORY GUIDE IN QUALITATIVE CHEMICAL ANALYSIS, by H. L. Wells, M. A. New York: John Wiley & Sons. London: Chapman & Hall, Limited. 1898.

Prof. Wells, who lately brought out a new authorized translation of Fresenius, now presents a method of teaching widely different from the one which, under the influence of the great German master, has become practically stereotyped in most schools of chemical instruction. The analytical methods of Fresenius still form the basis, with some commendable modifications and additions; it is in the manner of bringing the reactions to the students' notice, however, that the originality of the work is most striking.

The method adopted is essentially experimental; instead of taking up one radical at a time, describing its reactions with various reagents, and then having the student make confirmatory tests—a procedure which too often results in perfunctory work and induces a disposition to take the thing for granted, or be satisfied with a very imperfect reaction—the pupil works from the start with radicals whose identity has been purposely concealed; his attention is concentrated upon the conditions of his manipulation and the expectancy of an unforetold result. Then, by repetition of the same processes upon a series of labelled solutions, he is led to identify the unknown by its exact conformity in behavior with one of the known radicals. The natural result is a sustained interest, a rapid introduction into habits of exact manipulation and careful attainment of proper conditions for each reaction, and the collateral acquirement of many facts concerning other radicals, and especially the comparative conduct of different members of each group with each reagent.

The method seems somewhat laborious, but undoubtedly would prove quite the reverse when measured against the proficiency attained; not the least excellent feature is the gradual preparation of the student for the exact manipulations of quantitative analysis—a feature too often ignored in the qualitative laboratory.

The order of the work is logical and the review features excellent; in fact, it is, to a great extent, an application of the inductive system which proves so efficient in other departments of educational work. The chapter on ionization and ions is of doubtful value; the effort to condense has made it too abstruse for the average chemical student, at least at that stage of his education. The binding in of several sheets of perforated labels is distinctly an undesirable feature, as their removal will infallibly injure the binding. It is to be hoped this will be omitted in the later editions which the work well deserves, for as a whole it is excellent and to be strongly recommended to the attention of every instructor and student.

MACHINISTS' AND ENGINEERS' POCKET MANUAL. Edited by D. B. Dixon. Chicago: Laird & Lee. 1898.

It is inevitable that a book will be judged more by what it lacks, if it lacks much, than by what it contains; and it is unfortunately true that this book, by attempting too much, too wide a range, has destroyed its chance for usefulness.

The first 124 pages are devoted to a dictionary of about 2000 mechanical and electrical terms, in which "Abscissa of rectilinear co-ordinates" is defined but "co-ordinates," "rectilinear," "axis" and others of the equally important and abstruse meanings which are indissolubly associated with abscissas, are ignored, a fault which runs through the whole book. But this, bad as it is, is not so bad as some of the definitions. For instance "Volt"—The practical unit of electrical pressure, etc." Is it not a theoretical unit also? "Indicator, Automatic—Any automatic

device for electrically indicating, etc." Why necessarily "electrically"? Why make the compilation at all if it does not and cannot fulfill the functions of a dictionary? What then is its use? The only answer to these questions seems to be, "To sell."

There is a table of squares, cubes and their roots up to 1595; tables of weights of flat, round and square iron (but none of copper, brass or aluminum), and, besides still others, a table of hyperbolic logarithms. A series of questions and answers for the examination of stationary engineers; some matter on gear and screw-cutting, refrigerating machinery and the taking of indicator cards are the most important of the other subjects touched upon.

PRELIMINARY SURVEY AND ESTIMATES, by Theodore Graham Gribble, C. E. Text-Books of Science series. Second edition. London, New York and Bombay: Longmans, Green & Co.

We conceive that there is no more just way of introducing an author to his public than to let him speak for himself wherever it is possible, and we therefore extract from Mr. Gribble's introduction a few sentences which seem to us the key-note of his work.

"The American is just an Anglo-Saxon like ourselves, only with a little more liberty and a great deal more scope. He is not at all ashamed to come and learn from the old country what age and experience have qualified her to teach. . . . In simplicity of survey practice, uniformity of gauge, types of bridges and of rolling stock, the American engineer may be profitably (though not slavishly) imitated in the work of opening out a new sphere of enterprise. . . . The methods of surveying considered in the following pages are by no means exclusively American. In the class of work formerly called telemetry, but now tacheometry, we have to go to Italians, French and Germans for most of the original conceptions and the best modern developments."

In these days of tribulation when "alliance of English-speaking races," "commercial union," "community of interests," and other comforting sentiments seem to be in every English-speaking mouth on both sides of the Atlantic, it is gratifying to an American engineer to find that he is at last understood by his practicioner-germane.

The claim to eclecticism which is made in the previously quoted paragraphs is justified by the contents of the book, for it is a treatise, at once so clear, so scholarly and so discriminating that, with Wellington's "Theory of the Location of Railways," it may properly be said to cover the whole range of railway work up to the commencement of construction.

Nor is it confined to this, as will be seen by reading the chapter-headings which follow: General Considerations, principally devoted to railways. Route-Surveying or Reconnaissance. Hydrography and Hydraulics. Geodetic Astronomy. Tacheometry. Chain-Surveying. Curve-Ranging with Transit and Chain. Graphic Calculation for Preliminary Estimates, in which the application of the slide-rule to railway work is demonstrated. In the chapter on Instruments, Mr. Gribble gives the best dissertation on their construction and use that it has ever been our fortune to read. Not the least valuable feature of this part is a description of the tacheometer theodolite built after his own design.

A chapter entitled Parliamentary Work has only an academic interest for American engineers, since it deals principally with the requirements of Parliament relating to railways and other public works. The Resurvey of Railways, an Appendix (consisting mostly of tables and mathematics), a Glossary, some suggestions as to Light Railways for the Cape of Good Hope and an Index, complete this unusually satisfactory book.

BOOKS RECEIVED.

Practice and Theory of the Injector. By Strickland L. Kneass, C. E. Second Edition, Revised and Enlarged. New York: John Wiley & Sons. London: Chapman & Hall, Limited. 1898.

Thermodynamics of the Steam Engine and other Heat Engines. By Cecil H. Peabody. Fourth edition, rewritten and reset. New York: John Wiley & Sons. London: Chapman & Hall, Limited. 1898.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them.
Please mention The Engineering Magazine when you write.

Westinghouse Electric and Manufacturing Co., Pittsburg, Pa., U. S. A.=Catalogues (*a*) Electric Street Railway History; (*b*) Quarter of a Million Horse Power of Polyphase Electric Transmission Apparatus; (*c*) Polyphase Inductor Generators; (*d*) Generators and Rotary Transformers for Electrolytic Work. All are very handsomely illustrated and printed.

Garvin Machine Co., New York.=Illustrated catalogue of machine tools, including milling machines, screw machines, tapping machines, drill presses, and gear cutters, with many auxiliary tools, cutters, &c., together with cable code words for each article.

Baldwin Locomotive Works, Philadelphia, Pa., U. S. A.=Record of recent construction, No. 7. Pamphlet containing illustrations and specifications of locomotives built for use in the United States, Brazil, Hawaii, and Mexico.

Consolidated Safety Valve Co, New York.=Revised and enlarged catalogue of "Pop" safety valves of various types, water relief valves, and mufflers.

C. W. Hunt Company, New York.=Illustrated catalogues (*a*) of mast fittings, coal tubs, hoisting blocks, and wheelbarrows; (*b*) of industrial railways for manufacturing establishments; and (*c*) of Manila rope for transmission and hoisting. These catalogues all contain much general information of value to the engineer and manufacturer, in addition to the presentation of the various articles.

Joseph Dixon Crucible Co., Jersey City, N. J., U. S. A.=Helps in brazing, being a description of the new dipping method of brazing bicycle frames and similar articles by the aid of the Dixon brazing crucible, brazing graphite, and anti-flux.

The New Britain Machine Company, New Britain, Conn., U. S. A.=Catalogues (*a*) of case steam engines; (*b*) of chain saw mortisers. Both catalogues are very complete and exhibit important and successful products in an excellent style.

The Williams Gauge Co., Pittsburg, Pa., U. S. A.=Illustrated pamphlet descriptive of the Williams safety steam boiler governor, a device for regulating and controlling the water level; also of the Williams pump governor and pressure regulator

Whiting Foundry Equipment Co., Harvey, Ill., U. S. A.=General catalogue of cranes, elevators, cupolas, ladles, trucks, tumblers and general foundry supplies.

The Wm. Powell Co., Cincinnati, Ohio, U. S. A.=Pocket edition of general catalogue of steam brass goods, including valves, lubricators, sight-feed oilers, water-gauges and cocks, and general brass goods for use with steam.

Lincoln Iron Works, Rutland, Vermont, U. S. A.=Illustrated pamphlet of stone sawing machines, both gang and circular, adapted for cutting hard or soft stone.

The Burt Manufacturing Co., Akron, Ohio, U. S. A.=Pamphlet illustrating the Cross oil filter for cleaning and recovering lubricating oil in manufacturing establishments to permit its repeated use.

Macleod and Clark, Cincinnati, Ohio, U. S. A.=Catalogue of the Buckeye light for contractors' and foundry use, also illustrating and describing Buckeye kerosene rivet-heaters and forges, contractors' hand pumps, paint-spraying machines, pulsating pumps, and steam traps.

International Correspondence Schools, Scranton, Pa., U. S. A.=Pamphlet giving a full synopsis of the course in telephony, as taught by correspondence, together with a general description of the character and importance of the subject, method of teaching, and vocations in which such knowledge would be of value.

W. W. Lawrence & Company, Pittsburg, Pa., and Buffalo, N. Y., U. S. A.=Pamphlet discussing protective coatings for iron and steel and setting forth the proper uses of Lawrence permanent paint No. 2050, and Lawrence asphaltic bridge conservative No. 1033.

Sullivan Machinery Company, Chicago, Ill., U. S. A.=Catalogue No. 32, containing illustrations and descriptions of Sullivan mining machinery, including shearing and undercutting machines for coal mining as well as rock drills, and diamond drills.

John A. Roebling's Sons Company, Trenton, N. J., U. S. A.=Handsomely illustrated catalogue of the Roebling system of fireproof construction giving details of its application to different portions of a structure, together with illustrations of numerous buildings to which the system has been applied; also pamphlet reprint of an essay on fire-proof construction by A. L. A. Himmelwright, C. E., discussing the general conditions of fire-proofing as required for the modern tall building.

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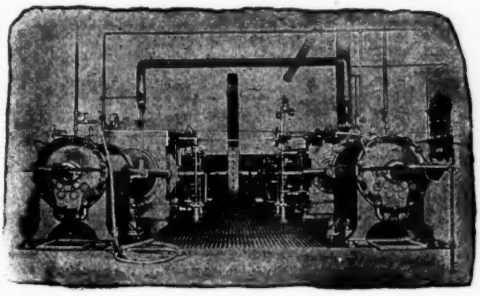

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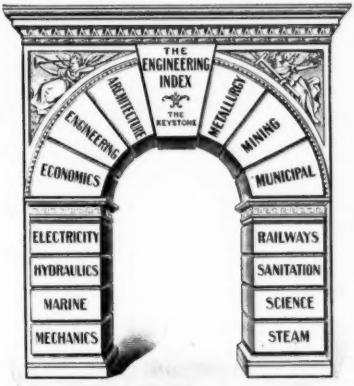

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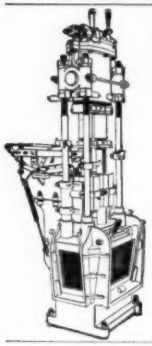

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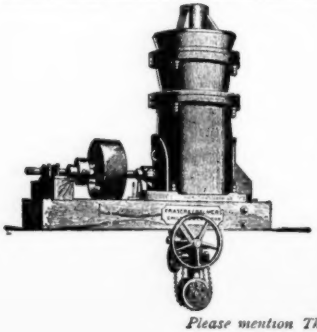

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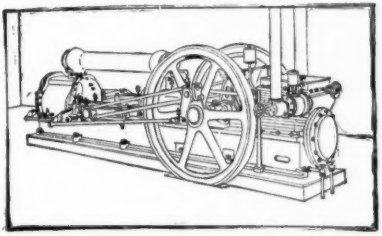

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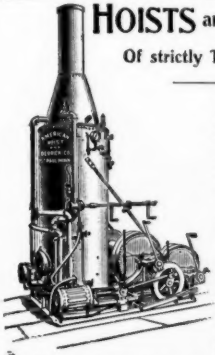

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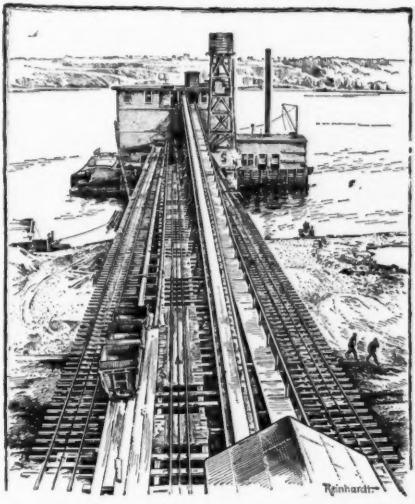

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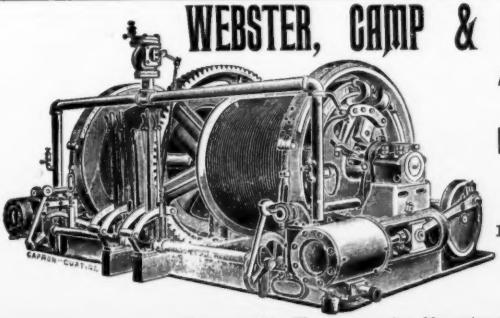

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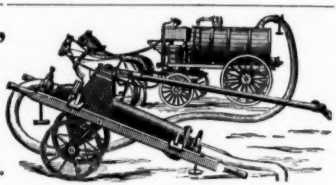

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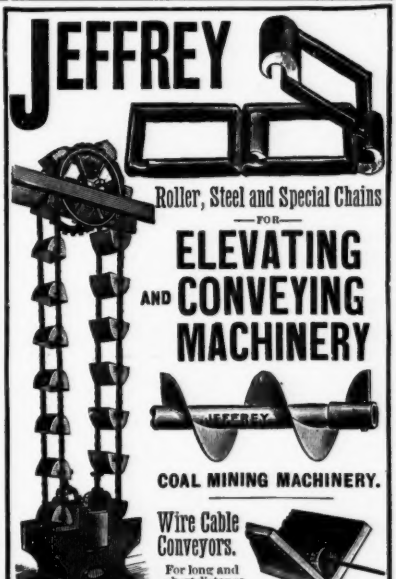

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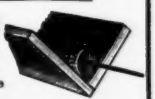

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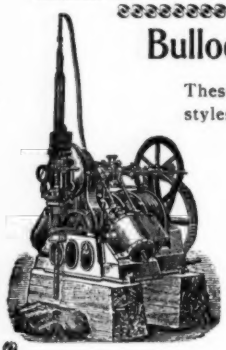

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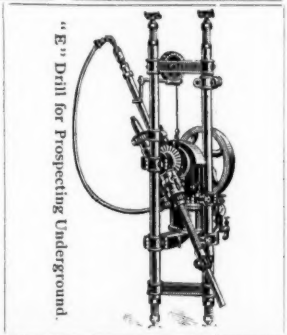

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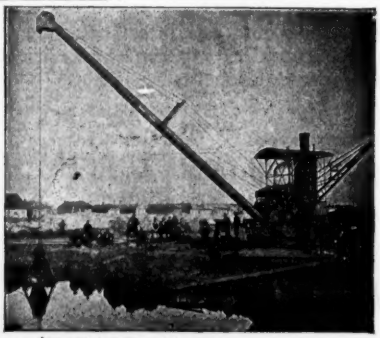

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